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BULLETIN No. 5.—NEW SERIES.

U. S. DEPARTMENT OF AGRICULTURE.

DIVISION OF ENTOMOLOGY.

INSECTS AFFECTING DOMESTIC ANIMALS:

AN ACCOUNT OF THE SPECIES OF IMPORTANCE IN NORTH AMERICA,

WITH

MENTION OF RELATED FORMS OCCURRING ON OTHER ANIMALS.

PREPARED UNDER THE DIRECTION OF THE ENTOMOLOGIST,

BY HERBERT OSBORN,

Professor of Zoology and Entomology, Iowa Agricultural College, Ames, Iowa.

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF ENTOMOLOGY,
Washington, D. C., July 8, 1896.

SIR: I transmit herewith the manuscript of a report upon insects affecting domestic animals in the United States. This report has been prepared by Prof. Herbert Osborn, of the Zoological Department of the State Agricultural College at Ames, Iowa. Professor Osborn was a field agent of this Division for some years prior to 1893, and was engaged, during part of the time of his employment by the Department, in the preparation of this report. As explained in the prefatory statement, it was the intention of Professor Riley to collaborate with Professor Osborn in this work, but other duties interfered. The report, in its present condition, is largely the result of work done by Professor Osborn, under a special commission from the Department during the past winter. The chapter on remedies has been carefully read and revised by Dr. D. E. Salmon, chief of the Bureau of Animal Industry. The report will form an excellent text-book of the subject, and is a work which, in the opinion of the writer, should be in the hands of all stock raisers. I recommend its publication as Bulletin No. 5, new series, of this Division.

Respectfully,
L. O. HOWARD,
Entomologist.

Hon. J. STERLING MORTON,
Secretary of Agriculture.

PREFATORY NOTE.

The report herewith submitted was originally planned in 1885 as a conjoint work with Dr. C. V. Riley, the intention being that the writer should make a first draft of the matter, presenting the results of his own studies, and that the material should then be reviewed by Dr. Riley to make such corrections and additions as the material in his hands might permit. On this basis, manuscript was prepared and transmitted to Washington at intervals up to 1890, but the numerous duties of Dr. Riley, especially his work for the Paris Exposition in 1889, prevented his giving any attention to this matter, and in 1890, at his suggestion, the chapter on "Pediculi and Mallophaga," which had been my special study, was put in shape for the press and issued shortly after as Bulletin 7 of the series of Division Bulletins. The other matter was held in reserve, though receiving attention at times when other work permitted.

After Dr. Riley's death his successor, Dr. Howard, found the writer's incompleted manuscripts and proposed that they should be revised, completed, brought up to date, and published—a proposition which I was very glad to accept, as it seemed after so much of my time had been given to this work while in the employ of the Division of Entomology it was but right that there should be some published results.

In completing the work the original plan and scope has been followed in most respects, but it has been found necessary, on account of the mass of material collected, to restrict the treatment of the species, giving special prominence only to those forms of interest to the American stock breeder and poulterer, and especially in the bibliography to limit the titles.

While a large number of the figures have been prepared expressly for this work, a number have been secured from other sources, and will be found duly credited in each instance. Of the original figures, 34, 36, 50, 51, and 52 were prepared in the Division of Entomology; the others have been drawn by Miss Charlotte M. King, under my personal supervision.

I take this opportunity to acknowledge my indebtedness to Professor Riley for his interest and assistance in the inception and preparation of the report, and to Dr. M. Francis, Prof. S. A. Forbes, Dr. A. S. Packard, Prof. Lawrence Bruner, Dr. A. Hassall, Prof. J. H. Comstock, Mr. C. F. Baker, Mr. S. E. Cassino, and others who have kindly aided me with the use of cuts or with specimens for study. To Dr. L. O. Howard I am under especial obligations for most valuable aid in the final revision and completion. He has taken great pains to furnish me references not otherwise at command and to provide illustrations.

HERBERT OSBORN.

Iowa Agricultural College, Ames, Iowa.

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INSECTS AFFECTING DOMESTIC ANIMALS.

CHAPTER I.

INTRODUCTION.

DEFINITIONS AND ARRANGEMENT.

The relations which insects bear to the other branches of the animal kingdom are of no little complexity, and the complete statement of these relations would require a lengthy discussion of definitions.

In the present work it is intended to discuss particularly those insects which by direct attack upon domesticated animals render themselves an injurious element to the stock breeder, poultry raiser, and keeper of various animals for pleasure or profit. Naturally, reference must here and there be made to allied forms which may be of interest as affecting some related animals or as possible parasites of domestic animals in the future.

Insects may affect domestic animals in a number of different ways: first, by occasional attack for the purpose of obtaining food; second, by occasional attacks which simply give irritation to the animal, as in the case of certain species of flies; third, by living as parasites during part of their existence, as in bots; fourth, by living as parasites throughout their lifetime, as with the lice; and, fifth, by living as mess mates or scavengers upon the bodies of the animals without deriving nutriment from them, as, probably, some species of bird lice.

In general, the insects affecting animals are termed parasites, but evidently this term would not be appropriate for all the forms above mentioned. It is by no means easy to give a definition which shall be properly exclusive.

We may say that a parasite is an animal which lives at the expense of another, but this would not include many species which are commonly considered as parasites and which, while dependent upon a host animal for existence, take nothing that is of value to the host. On the other hand, if we say the parasite is an animal dependent at some period of its life upon another for existence, we must include many forms which have none of the habits which we commonly associate with parasitism.

Van Beneden has proposed three groups—parasites, messmates, and mutualists. In the first group are placed all those forms which feed upon the tissues of the host. In the second group are placed those which simply take the food collected by the host, but do not demand its own substance. In the third group are placed those which simply ask protection or an opportunity to procure food in connection with, or to live upon cast-off portions or rejected matter from, the host.

In later writings, many of which have appeared since the first writing of this chapter, this grouping has been more or less modified, and a careful summary derived from the works of Leuckhart, Looss, Blanchard, Neumann, Railliet, and others is given by Dr. C. W. Stiles in the Proceedings of the Entomological Society of Washington. (Vol. III, p. 6.) This arrangement, in brief, is:

A. Based on Symbiosis and food: (1) Mutualists; (2) Commensalists; (3) True parasites; (4) Pseudoparasites; (5) Spurious parasites.

B. Based on position: (1) Ectoparasites; (2) Endoparasites.

C. Based upon the animal or plant: (1) Phytoparasites: (*a*) in or upon animals; (*b*) in or upon plants; (2) Zoo-parasites: (*c*) in or upon animals; (*d*) in or upon plants.

D. Based upon time: (1) Temporary parasites; (2) Stationary parasites: (*a*) Periodical parasites; (*b*) Permanent parasites.

E. Based upon adaptation or necessity: (1) Facultative parasites; (2) Obligatory parasites.

F. Based upon the number of hosts: (1) Monoxenous parasites; (2) Heteroxenous parasites.

A careful examination of the subject will show that none of these groupings furnish a satisfactory basis for a systematic plan of treatment, in a work of this character at least, since we may have a number of these rôles assumed by the same insect at different periods of its existence or under different conditions.

It has seemed, all things considered, the most feasible plan for this work to include all insects directly injurious to the animal economy, or directly associated with domestic animals, to take up the different species in their zoological order, so that similar forms may be treated together and repetition may be avoided, and to treat each species as fully as possible, giving its past history, extent of injury, habits, and life history, and finally methods of preventing or relieving its injuries.

In order to furnish a convenient key to the different species and enable the different forms occurring upon one animal to be seen together, a table has been arranged according to animals infested, constituting Chapter VIII. Then a chapter is devoted exclusively to a discussion of remedial measures, methods of prevention, and notice of animals which have parasites in common.

The group of worms is excluded from this work, as it would too greatly extend it, and, moreover, the most important species have received quite thorough treatment in veterinary works and special treatises which are available to those desiring information regarding them. Moreover, these parasites are less under the control of the breeder except in the way of prevention.

In order to show more fully the relations of the parasitic species, a brief review of the classification of those included will be of assistance.

GROUPING OF PARASITIC INSECTS.

The group of insects taken in its wider sense or as usually given in the older text-books (the Tracheata of modern systems) includes all those animals having jointed bodies with jointed limbs and breathing by means of trachea or respiratory tubes distributed throughout the body.

This main group is divided into four subgroups: The Hexapoda, or Insecta proper, including all the six-footed, winged forms; the Arachnida, including the eight-footed forms, none of them winged or provided with antennæ, and with the body not distinctly separated into head, thorax, and abdomen (spiders, mites, ticks, etc.); the Myriopoda, having elongate bodies and numerous legs (centipedes and millipedes); and the Malacopoda, containing a few species of worm-like forms confined to tropical latitudes.

Of these only the two former contain species to be considered in this connection, unless, indeed, reference be made to the centipedes, which, from their poisonous nature, may at times have an injurious effect on man or domestic animals.

The subgroup Hexapoda is divided into a number of orders, and the tendency among recent systematists is to increase the number of these orders so that from sixteen to nineteen are recognized in different systematic arrangements. For the purpose of this work, we may enumerate nine groups which may be considered as equivalent in most cases to orders, though some of them, notably the Neuroptera and the Pseudoneuroptera, include several of the orders recently established.

These orders are the Hymenoptera (bees and wasps); the Lepidoptera (butterflies and moths); the Diptera (flies and mosquitoes); the Coleoptera (beetles); Hemiptera (bugs and lice); the Orthoptera (crickets and grasshoppers); Pseudoneuroptera (dragon flies, May flies, etc.); the Neuroptera (shad flies, caddice flies, etc.); the Thysanura (springtails).

In the first of these orders, Hymenoptera, no species parasitic on domestic animals occurs. Bees and wasps, by virtue of their stings, render themselves obnoxious to animals; but since their attacks are entirely in the way of self-defense, and never in the form of parasitism, and as such attacks are not limited to any species either of insect or animal attacked, we deem it unnecessary to make further mention of the group.

Of the Lepidoptera, no species attack the higher animals. The bee moths are sometimes very destructive in hives, but these will be found treated in works on the apiary.

The order Diptera includes a number of families containing parasitic or semiparasitic species. The members of this order are distinguished by having only one pair of wings, the second pair being represented by rudiments called halteres, balancers, poisers, etc. The Culicidæ include the mosquitoes which are notably irritating to a great number of domestic animals as well as to man. They are distinguished by the slender bodies and lancet-like mouth parts.

The Simuliidæ include the buffalo gnats, small, heavy-bodied insects, which, by their persistent attacks upon the eyes, ears, and other exposed parts of the body, as well as by their painful and frequently poisonous bites, cause intense suffering and often death to their victims.

The Tabanidæ include the large horse-flies. They have a very severe bite, and cause much discomfort to horses and cattle, and often to man as well.

The Œstridæ, or bot-flies, are truly parasitic during part of their lifetime, occupying various localities—the stomach of the horse, the frontal sinus of the sheep, subcutaneous tissue of cattle, rabbits, etc., and the testes of squirrels. In the adult form they are two-winged insects, with rudimentary mouth parts, and simply deposit their eggs in proper places for the young to gain entrance to their hosts. In this form they may do much harm, however, by worrying animals in their efforts to accomplish the deposition of eggs. As larvæ they live within the tissues of the host, passing from these to the ground to enter the pupal stage, and from this they issue in the adult form.

The Muscidæ, a large family, including such forms as the common house fly, the horn fly, and others, includes a number of species that are of direct importance in their attacks upon domestic animals. In some cases it is the irritation or bite of the adult; in others, as with the screw-worm and blow-fly, the larva becomes the inimical form.

The Hippoboscidæ include the sheep ticks and the bird ticks. The latter have the wings common to the other flies; the former is wingless. They have mouth parts fitted for puncturing the skin and drawing up the liquid contents of the tissues.

The Nycteribiidæ, or spider flies, are found only on bats, and are constant parasites. They are remarkable for their slender, spider-like bodies. They deserve mention because of their peculiar structure and special adaptation to parasitic life, notwithtsanding that they are not found upon domesticated animals nor likely ever to be.

The Pulicidæ, or fleas, are now usually placed in a separate order—the Siphonaptera—though in some respects they show affinities to the Diptera. They occur on a number of different animals, confining themselves in most cases to different species of hosts. They may live, however, much of the time free from the host and the larvæ develop independently of the host, though in many cases it must be that they are confined to the places occupied by the host.

The Hemiptera are distinguished by having the mouth parts adapted for suction and the wings either membranous or with the basal half of the fore wings thickened and leathery. The order contains three suborders, the Heteroptera, Homoptera, and Parasita. The first includes those having the fore wings thickened at base. In this division we have the bed-bugs and cone-nose, and in the family Belostomatidæ insects which prey upon young fish. The common *Belostoma americanum* and the *Benacus griseus* may prove at times quite destructive in this manner, and if fish culture should become an important industry for the utilization of ponds and streams, and such species as the carp be kept in a state of practical domestication, such insects might be thought to come within the scope of our work. The adult insect is strongly attracted by electric lights, and in many localities has received the name of "electric-light bug." Not infrequently curious observers are made to suffer from the punctures of its powerful beak. Should the species require practical attention its gathering at lights could be made the basis of effective measures for its reduction. At present it need not be considered as requiring notice in a work of the scope assigned to this paper.

In the homopterous division of the Hemiptera no species are known to be of importance in this connection.

The suborder Parasita includes the families Polyctenidæ and Pediculidæ, the latter of which only is of consequence as affecting domestic animals. These are degraded, wingless forms occurring on nearly all species of mammals, and may be considered as the most truly parasitic of any of the forms we shall consider, their whole existence being confined to and dependent upon a certain host.

The group of Mallophaga, including the bird lice, has been of somewhat doubtful position, but at present authors are generally agreed that they have their affinities with the Pseudoneuroptera, in which group they naturally fall near the family Psocidæ, which includes the minute book lice so common in books, herbariums, insect collections, etc. The group is well marked, though somewhat aberrant, doubtless a result of the very distinct parasitic habit of all the species. It is unnecessary to go into a discussion of its zoological position here. The species are all entirely wingless and may be easily distinguished from the Pediculidæ by their biting mouth-parts, the jaws being well developed. They are all confined to warm-blooded animals, birds and mammals, by far the greater number being parasitic on birds.

The group contains two well-marked families,[1] quite easily separated by the structure of the feet. The Philopteridæ having but very short tarsi and being unable to travel rapidly, while the Liotheidæ have well-developed tarsi and run with great rapidity and ease.

The Neuroptera proper, which is divisible into several orders, does not contain any species that are to be counted among the insects affecting domestic animals directly.

The Thysanura, including the little spring tails, would scarcely seem likely to present any parasitic forms; but Mégnin[2] has described a species, *Podurhippus pityriasicus*, as affecting horses parasitically.

The Arachnida are for the most part readily separated from the insects proper by the presence of four pairs of legs and are represented by the familiar spiders, ticks, mites, scorpions, etc. The parasitic forms, however, are included in the order Acarina, and in this order are confined to the families Trombidiidæ, Gamasidæ, Ixodidæ, and Acaridæ, the latter including the specially parasitic subfamily Sarcoptinæ. The first family can scarcely be called parasitic, the species living on vegetation, but occasionally attaching themselves to animals and causing intense suffering. The Ixodidæ also breed upon vegetation, but depend upon attaching themselves to mammals in the later stages of their development, and with some, at least, this seems essential in the maturity of the reproductive organs, especially the development of the eggs. However, certain species will be found to infest regularly certain species of mammals, those infesting cattle, rabbits, squirrels, etc., each adhering as a rule to its particular species of host. Some of these reach a considerable size, as the dog tick, one-half inch or so in length, when fully extended with eggs.

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[1] Kellogg, in his "New Mallophaga," proposes a new family arrangement, making a family Trichodectidæ for mammalian philopterids.

[2] Les Parasites and les Maladies Parasitaires, p. 104.

The Acaridæ are very minute mites which produce itch, scab, mange, etc., some of them living on the surface of the skin and others burrowing within it.

LIFE HISTORIES OF PARASITES IN GENERAL.

In their general life history, many of the parasitic insects travel nearly identical courses, owing to the similarity of the conditions under which they live. But when we consider the semiparasitic forms and free species we meet a great variety of habit.

The mosquitoes, horse-flies, and buffalo-gnats are troublesome to animals only in the adult stage, their early stages, except in the case of the flesh-flies living in wounds, or of the bots, being passed in an entirely different manner. The mosquitoes, as is well known, live in water as "wigglers," then become pupæ, still aquatic, then issue in the full-winged form, in which stage they make their attacks upon the higher animals and finally deposit their eggs on the surface of water. The horse-flies pursue a very similar round of life, but require a much longer time for the various stages of development.

The bot-flies, on the contrary, as already hinted, do all their injurious work, except that resulting from fright, in the larval form, at this time being parasitic within the host animal. The pupæ and adults are incapable of harm in themselves. It must be stated, however, that the adults are a serious annoyance on account of the terror which they inspire in horses, sheep, and cattle when hovering about them to deposit their eggs. Whether this terror is due to an instinctive knowledge on the part of the animal as to the injurious nature of the insects, as has been argued by some, or whether because of their resemblance to bees or wasps, or horse-flies, which experience has taught to be capable of causing pain, we can not pretend to say with assurance. Certainly, the effect of such fright is anything but desirable, except as it serves to protect, in some degree, the terrified beast.

Fleas propagate in the dust of dwellings, in the litter of the resorts of the animals they infest, or attached to the hair of animals.

Sheep ticks and bat ticks have acquired a remarkably specialized mode of reproduction as a consequence of their parasitic habits, which must be dealt with in detail in discussing that particular group.

All of the different kinds of suctorial lice pass through the successive stages of growth upon the particular animals they infest. The eggs, commonly called "nits," are attached to the hair of the host and hatch into young lice which resemble closely the adults, differing only in size and in the hardness of certain parts. The rate of propagation and the time involved in passing through the different stages have been determined for but one species, and that under conditions which make it uncertain as a basis for calculating possible rate of increase even for that species. Much less can it be taken as a basis of measure for the development of other species.

We know, however, that the rate of increase is at times very great. Frequently an animal when first observed is so thickly covered with vermin that the owner thinks they must have come by some other than the ordinary means of reproduction. The lice are frequently found in greatest numbers in the spring of the year, but it is quite doubtful whether this is due to increased rapidity of reproduction in the winter season. It seems most likely that the reproduction is more rapid during summer, but the animals are then in a thriving condition, constantly in the open air, and by their own efforts keep the lice from making such headway as to produce noticeable results. During winter, however, one or two generations even, from the numerous flock present when the animals are housed, furnishes such numbers that their presence tells upon the economy of the animal and it is no longer able to contend with its foes. The result is loss of hair, poor condition, reduced vitality, and, finally, unless active measures are adopted for its relief, a fatal result.

The life history of the bird lice is very similar to that of the suctorial forms. Eggs are attached to hairs or feathers and the young, constantly resident upon the host, grow by easy stages to the adult form. Observations on the period required for the incubation of the egg have shown that for one species, *Nitzschia pulicaria*, the time from deposition to hatching is from fifteen to twenty days. The rate of increase is apparently here less rapid than for the suctorial species, but still rapid enough in some species, as, for instance, the cattle and horse lice, to prove very troublesome to their hosts.

The mites, ticks, mange insects, etc., travel similar cycles of life wherever they are confined to the host throughout life; but for the harvest mites and ticks, which develop for a time on vegetation, the eggs are usually deposited loosely on the animal or upon vegetation and admit of the young obtaining a portion of their growth before attaching themselves to an animal host. The young resemble the adults in general outline, but it is a general rule that they have but three pairs of legs, whereas the adults as a rule have four. When gorged with blood the adults may become distorted in shape, when the resemblance to the young becomes less marked.

ORIGIN OF THE PARASITIC HABIT.

The problems of the origin of parasites, or the adaptation of certain forms to a parasitic life, are among the most interesting met with in biological investigation, but we can suggest merely some of them here.

It may be said from the biological standpoint that all parasites have been derived primarily from nonparasitic forms—a proposition which is supported by innumerable facts in their morphology and embryology, and which may also be argued deductively. Since many species are confined absolutely to certain animals as hosts, it is evident that they could not have existed as parasites upon such species at least before the occurrence of the host. Unless, therefore, we claim an independent origin for them subsequent to the origin of the host we must allow an adaptation from some free-living species or from a parasitic species on some other host, and following this back for its origin, we must ultimately arrive at a free form as the source.

In many cases the line of evolution is very apparent, as, for instance, the gradation between comparatively free and fixed Mallophaga, Acaridæ, Pulicidæ, etc.

RESULTS OF PARASITISM.

It is also interesting to inquire as to the effect of the parasitic life upon the parasite itself.

The natural tendency of an animal once started in the direction of parasitism will be to become more and more parasitic in habit, and with this habit a greater and greater specialization of parts with reference to this habit will be observed. The disuse of certain organs, as wings for flight and feet for ordinary locomotion, results in reduction or modification of these organs, and hence we find almost invariably that parasitic species are wingless, and that they have the feet adapted specially for locomotion among the hairs or feathers of the hosts. This adaptation is often looked upon as degradation; but it seems to me preferable to consider it as a limitation in certain directions with specialization of certain organs. We consider the foot of the horse highly specialized, and we must admit that the animal is limited in its use, as it can not climb trees, but we do not call the horse degraded.

It is true that the limitations for many parasites are so great that they are absolutely dependent upon certain hosts, and the presence of certain conditions for their existence—there is reduction or degradation of certain organs, but progressive specialization of those organs which remain functional. Often such specialization assumes a parallel character in widely divergent groups, as the clasping organs developed in pediculids, mallophagids, hippoboscids, and sarcoptids. In other cases the same effect is attained by a different process, as the flattening of the body vertically in fleas and horizontally in most other permanent parasites. Modifications of the mouth-parts, eyes, and antennæ are very great, and furnish most striking examples of the modification of structures for adaptation to special conditions.

DISTRIBUTION OF PARASITES.

With reference to all of the more strictly parasitic forms, we may say that each group of animals has its particular forms of parasites and that each species of bird or mammal may be said to have its particular parasite fauna, while each parasite has its special limit of host species.

Considering only the forms affecting birds and mammals, we find the Œstridæ confined to mammals, and of mammals the genus Dermatobia to Primates and Carnivora, Gastrophilus to Equidæ, Hypoderma to ruminant ungulates, Œstrus to Ovidæ, and Cuterebra to rodents.

Hippoboscidæ are confined to certain families of birds and mammals—Olfersia to raptores, Lipoptena alternates between birds of the grouse family and mammals of the deer family, Melophagus is confined to sheep, Hippobosca occurs on the horse, and Ornithomyia occurs on various birds.

The Pediculidæ are all confined to mammals—Pediculus to man, Pedicinus to monkeys, Hæmatopinus to Carnivora, Ungulata, and Rodentia, Echinophthirius to Pinnipedia, Hæmatomyzus to the elephants, and Hæmatopinoides to Geomys.

The Mallophaga are all confined to birds or mammals and with the exception of Trichodectes and Gyropus, which occur on mammals, all are confined to birds, Trichodectes affect Carnivora, Ungulata, and Rodentia, while Gyropus is confined to the guinea pig. The genera confined to birds have a quite varied distribution among the different groups, the same genus frequently having representatives in widely different families of birds, while any one species of bird may harbor a number of species in several different genera. Moreover, each species of Mallophaga favors some particular region of its host, certain species occurring on the wings, others on the breast and others on the neck and head.

The Pulicidæ affect both birds and mammals, and while less strictly limited than the lice, have usually definite range of hosts. Sarcopsylla has one species affecting mammals and another affecting fowls. Pulex contains species affecting both birds and mammals. Typhlopsylla occurs mainly on Rodentia and Insectivora.

The Sarcoptidæ and Linguatulidæ, which are the only permanent parasites among the arachnids, have definite hosts and usually little range of host forms. The genera occurring on birds do not ordinarily contain species affecting mammals, and, on the other hand, the genera occurring normally on mammals do not present avian parasites. The Linguatulidæ present a case of migratory parasites, the species being dependent upon two hosts, between which they alternate for particular stages of existence.

As regards the animals infested little need be said. For the domesticated species of mammals, cattle evidently support the largest number of species of external parasites and the horse the greatest number of internal parasitic insects, while the hog has the least.

Of the birds, honors are about even between the hen and the pigeon. The turkey is somewhat more exempt.

EFFECTS OF PARASITES ON THE HOST.

The effects of parasites, or the presence of noxious insects upon the animal economy, may be considered under three heads: *A*. As direct agents of loss to the animal economy. *B*. As carriers of contagious or infectious diseases. *C*. As carriers of other forms of parasites.

Under the first head we must consider (1) the effect produced by the extraction of certain portions of the nutritive fluids of the body, (2) the loss of vitality due to the production of sores, obstruction of vital functions by pressure or clogging and formation ot scales, ulcers, etc., by the presence of the parasites, (3) the loss of energy due to irritation, worrying, and fretting of the animal.

For the first part it may be argued that the nutriment extracted is so infinitesimally small that it is not worthy of notice; but observe the amount one mosquito or louse is capable of holding, then multiply this by the thousands that may infest a single animal, then reflect that the substance they extract is already passed through the slow process of preparation for use by the tissues, and it will be seen that this drain is not insignificant. If left in the animal it would go to the formation of flesh, the laying on of fat, or the strengthening of nerve.

This loss, however, may not be so important as the loss from degeneration of tissue manifested in sores, ulcers, scabs, mange, etc., which make a heavy drain on the vitality of the animal and prevent the normal action of the skin, these in turn causing excessive irritation, uneasiness, and other derangements of the animal economy. Indeed, the occurrence of these conditions may be looked upon in many cases as the result of lack of nutrition of the affected parts due to the drain by the parasite.

The irritation of the presence of insects or their attacks upon some sensitive part of the animal is often of the greatest injury. To a nervous horse the uneasiness caused by the buzzing of the mosquitoes or flies is worse than the actual bites or loss of blood, while the intense irritation of buffalo-gnats in the eyes and nostrils, aside from their bites, is productive of the greatest distress. Doubtless much of the injury caused by lice is due to the irritation of their presence rather than to the loss from their eating. Especially is this true of the biting and running lice which feed upon the epidermal scales, hairs, and feathers, of little or no value to the host animal. Indeed, Van Beneden claims that these are not parasites, but mutualists, and are rather of advantage than otherwise to the host, since they clean up the cast-off matter. I must differ, however, from the learned author in this opinion, since the presence of these lice and the irritation of their movements is plainly evidenced by the animals in their sometimes frantic efforts to rid themselves of the pests.

The scratching of horses and cattle against posts, rails, etc., the dusting of chickens in ashes or road dust, and, finally, the effects to be observed in the weakening of calves, colts, etc., infested by these pests settles the question of their damaging effects, to my mind, decidedly in the affirmative.

As carriers of contagious or infectious diseases, the insects which attack domestic animals present an important subject for study, especially so since the increase of our knowledge regarding such diseases and their origin in the multiplication of micro-organisms. As yet comparatively little is known upon this point, but enough to show that it is deserving of greater attention than it has as yet received.

It has been shown that elephantiasis is due to germs carried by mosquitoes and it seems not improbable that other diseases may be carried by this same universal pest. The mosquito partially filled with the blood of one animal suffering from some infectious disease, alighting upon the body of another and inserting its already wet beak, may transfer with it germs of the disease as well as its own subtle poison, more likely still if it be crushed and the blood with which it is filled is spread over the pierced tissue. Since the above was written the following item in Psyche, Vol. V, page 24, has appeared and is so much to the point that we insert it here:

> *Insects as authors of epidemics.*—Dr. R. L. Maddox, in a paper read before the Royal Microscopical Society, details the results of further experiments in feeding insects, especially the common blow-fly, on the comma bacillus. His observations include a large number of microscopical determinations. The results of all his investigations lead him to believe that the comma bacillus from cultures can pass in a living state through the digestive tubes of some insects, and, through this fact, that such insects are likely to become an important means of distributing disease, especially to animals that feed upon them. This is in accordance with the views of Dr. Grossi, that "insects, especially flies, may be considered as veritable authors of epidemics and agents in infectious maladies." (Scientific American, December 18, 1886.)

Surgeon-General Sir William Moore (Medical Magazine, July, 1893) regards the dissemination of disease by flies as a matter looked upon with too much indifference, and instances an epidemic of anthrax which was spread by flies which had covered a carcass of a dog thrown into a ditch in Cortal. He quotes the experiments of Lawtschenks with flies and cholera germs, and observes that it is worth noticing, in that in India it is during the time and season of the greatest prevalence of cholera that flies most abound. The possibility of flies carrying the organisms of typhoid fever and phthisis is suggested, and the belief is expressed that leprosy is often conveyed by flies, which appear to be particularly fond of leprous sores, and the infecting in this way of a sore on a healthy person. There is no doubt that ophthalmia is so spread, and an instance is given of complete destruction of an eye from diphtherial inflammation following the sting (bite) in the eye by a fly which had apparently risen from a dunghill. (Entomological News, Vol. V, p. 18.)

The late Dr. John A. Ryder presented the following very decided opinion:

> *Cholera and flies.*—It may not be amiss to call the attention of the public to the great danger from house flies as agents in spreading the contagion in case there be an epidemic of cholera. I have repeatedly observed that these insects will ride for a number of miles on street cars and doubtless also upon other vehicles of transit, such as railway coaches, etc., though I have never made observations upon any conveyance but the ordinary tram or horse car. Suppose a case: Imagine a cholera victim upon the street or anywhere else vomiting. The flies present are attracted and drink until sated, and have their feet and mouth parts wetted with the vomit containing the germs. They then perhaps fly out into the street, take a place on a horse car, ride several miles, dismount, fly into another house, where the family are at dinner, and contaminate the food set before them with the germs of the cholera carried on the mouth parts and feet of the insects. Some of the family sicken and die, yet no one of them will ever perhaps suspect that the flies may have carried the germs, as supposed above, for miles from some other case. The safeguards are to at once clear away, disinfect with corrosive sublimate solution, and scald the spots where the vomit has been thrown, and to be vigilant in the use of fly-screens, fly-traps, etc. During the late war the late Professor Leidy pointed out, with beneficial results, that the common house fly was instrumental in spreading the contagion of hospital gangrene. Why not beware of this imprudent and ubiquitous little dipter in carrying and spreading the contagion of the dreaded Asiatic plague now menacing us?—(See Entomological News, Vol. III, p. 210.)

The determination in recent years of the connection existing between the cattle tick of the Southern States and the formidable disease known as Texas fever is a striking example of the importance of this question. This particular case is treated more fully in connection with the discussion of the cattle tick.

If we consider all contagious diseases as due to specific organisms, we may relegate them all to the rank of parasitic diseases, but leaving out all due to so-called microbes or micro-organisms as producers of specific diseases, we have instances where one parasite serves as the carrier of other and more injurious forms. For example, the louse and the flea of the dog have been found to serve as the intermediate hosts for a tape-worm (*Dipylidium caninum* L.) which also infests the dog, the tape-worm, when mature, extruding eggs which gain entrance to the external parasite. The dog, in licking or biting himself to destroy the parasites or relieve the irritation, swallows some of his tormentors, the young tape-worms are set free in the stomach, and there develop to maturity.

LOSSES DUE TO PARASITES.

It is practically impossible to make any accurate estimates of the losses resulting in a great many of the forms of insect attack upon domestic animals. Naturally, no notice is taken of their presence or the losses they occasion until some of the animals are so seriously affected as to lose flesh or be threatened with death. In the meantime the loss must have been very great, since all of the animals must have been fed sufficiently to provide for the parasites, and also to keep up the increased vitality of the animal to meet the demands made by the presence of an irritating agent.

For actual statistics we must confine ourselves to instances where the presence of the parasites has resulted in the actual death of numbers of animals, or to a recognizable loss or depreciation on the animals or some product from them. These must naturally fail to present the whole truth, since isolated cases of the same kind will generally fail to be recorded.

Murray cites Delafond and Bourgignon as authority for the statement that in the valley of Prattigau, in the Grisons, Switzerland, in the years 1851, 1852, and 1853, out of upward of 2,500 goats, the half were attacked and 500 died from effects of the parasitic mite, *Symbiotes bovis.*

Reference to the sections on buffalo-gnats and bot-flies will show some instances where more or less definite figures can be cited as to the losses to stock industries from the attacks of injurious insects. It will suffice to mention here that the loss in a single county of Tennessee from buffalo-gnats in the one year 1874 was estimated at $500,000, and similar losses have occurred in many different years and over large tracts of the lower Mississippi Valley. Or we may cite the estimated loss in the United States due to one single species of bot-fly, $50,000,000, a species, moreover, which could be exterminated more certainly and quickly than any other with which we are acquainted.

POPULAR NOTIONS ABOUT PARASITES.

There are certain widespread notions regarding the presence of parasites or vermin on stock, and it may be in place to call attention to one or two of them here.

One of these is that only poor or weak animals are infested, and that of animals otherwise similar they will attack lean rather than fat ones. It may be quite frequently the case that animals noticed as "lousy" are the weak ones of the herd, but it should be remembered that the lice seldom attract attention until they become so numerous that their effects on the animal may be the real cause of its poor condition. It can not, certainly, be the case that they select only the weak and lean, for we have found lice in very fair numbers on animals in apparently as good condition as any others in the herd, including those upon which no lice at all could be found. It is true that certain animals in the herd may remain entirely free from lice, even when others in the same herd are badly infested, but that this is due purely to their being fat or in excellent health seems open to much doubt.

Another idea is that white cattle are infested rather than dark ones, an idea which we have heard most emphatically urged by many stockmen familiar with the subject. We have not had opportunity to personally examine a sufficient number of herds and compare the ratio of infestation among cattle of different colors to satisfy ourselves that there can be much of truth in it.

In one herd examined with some care the Holstein cattle were more generally affected than those of other breeds, but these had a preponderance of black in their color, and on this account the "nits" were especially conspicuous. In the same herd, however, one red heifer was quite as badly infested perhaps as any of the others.

It is not always safe, however, to set aside the conclusions of experienced men in any branch of industry, however little foundation they may seem to have from a logical standpoint; and if these ideas prove to be supported by fact, we will no doubt in time learn the reason for such selections on the part of the parasites. It is, in fact, a point of rather general observation that in the human family mosquitoes, flies, and other insects will appear to select certain individuals in preference to others, which we may consider as due to some peculiar condition of the skin or its secretions. Flies seem to take particular pains to settle on the exposed parts of sick people, and lice, itch mites, etc., if certain observations and records are to be accepted, show a decided tendency to infest certain persons and to be either unable or unwilling to harbor upon others. Certain people exhibit much greater susceptibility to such attacks than others, and with the harvest mites or "chiggers" this amounts to practical immunity from attack by some when, under similar conditions, others are most seriously troubled. Whether this is due to some condition of the skin that attracts in one case and repels in the other, or simply that in one case there is particular sensitiveness, while in the other there is not, the effect on the persons is in one case the extreme of irritation and in the other freedom from it. If similar conditions exist among the lower animals, we may suppose the attractive influence of conditions of the skin in certain animals—and this in animals of unhealthy action of the skin—might act as a positive influence. As far, however, as difference in color is concerned, unless this is associated with some very constant difference in conditions of the skin (such as thickness, density of the hair or diameter of the individual hairs, or in the secretions) better suited to the clasping, protection, or subsistence of the lice, there would seem to be slight foundation for the influence in selection.

The fact that lice infesting one species of bird or mammal are in many cases incapable of existing upon the bodies of other species has doubtless a foundation in difference of the skin or its secretions or in the size of the hair. The thickness of the skin varies greatly in different animals, and consequently the proboscis of a species adapted to some thin-skinned species might be entirely incapable of reaching the capillaries from which its food supply must be drawn in a species having a thicker skin. The secretions of the integumentary glands are doubtless of very different nature in different species, or, as already hinted, of the same species under different conditions. This might be a sufficient repellant influence simply from the difference in odor, a difference we know to exist in different animals, or, for the species feeding upon the scales or excreted matter on the skin, a difference in the material making it unsuited to them for food. We must remember that the parasites have become adapted to certain species of animals through a long course of evolution and differ almost as much in their characteristics and necessities as the animals upon which they live. It may be worthy of note, in passing, that the most odorous of animals are comparatively free from parasites. The skunk,[1] for example, has never been credited with harboring lice but in a single case, and this one (*Goniodes mephitidis* Pack.), once reported, if correctly referred to Goniodes, has much of doubt in it, since all species of this genus are strictly bird parasites, and the specimen described may have been an accidental visitor on the skunk derived from some bird which had served it for food.

To the practical stock breeder all these questions are simply subsidiary to the one of how to contend with these various pests, and especially those which cause a serious loss.

In general, it is most important for him to know to what extent a certain insect is capable of doing injury, the time and mode of its attack, the animals it may affect, and the best methods to adopt for the prevention or check of the injury.

While in some of the insects to be discussed here the different stages of their existence appear to have little to reveal concerning the methods of treatment, there are others which we can hope to deal with only from a thorough knowledge of all steps in their development as a foundation. We hope the reader who has any desire to make use of such knowledge will have patience with those parts which may seem to him unnecessary details, remembering that it is often in some minor detail of existence, apparently of slightest importance, that we find the clew to successful warfare with a serious pest.

Much annoyance may be saved in some cases by a knowledge of the animals to which certain species of parasites are confined, both by preventing infection among those to which a certain parasite is common, and by avoiding the trouble of unnecessary restrictions in case the parasite can not occur on two or more animals which it is convenient to allow a common pasture, corral, or stable. The list of parasites arranged according to host animals, Chapter VIII, which has been prepared with care from all accessible records concerning such species, will form a ready means of determining such questions without having to spend time in reading through the body of the work to find it.

The subject of remedies and preventive measures is treated fully in a separate chapter, and we wish here only to allude in the briefest manner to a few general principles which should be kept in mind in all cases of insect attack upon domestic animals.

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[1] We include elsewhere description of a louse, *Trichodectes mephitidis*, that has been found in abundance on the skunk.

As with many other insects, it is frequently much easier to *prevent* than to *remedy*, and if careful attention is given to the matter the stock breeder may, for many of the pests here enumerated, gain for his herds practical immunity, even if other herds in the vicinity are infested. This is true for all species that are incapable of flight, or that depend for distribution on the direct association of infested animals with those that are free, or that, by attaching themselves to posts, rails, etc., where animals rub themselves, may be transferred from one to another. Prevention is also the most important measure with the internal parasites, bots, etc., which are with difficulty reached when lodged. With many others, however, such as mosquitoes, flies, ticks, etc., and with lice, mites, etc., if they have gained a foothold, direct treatment is absolutely essential. Here there is necessity for examination of the conditions and adoption of one of two forms of treatment, according to the circumstances. The first, *repellant*, where, as with mosquitoes, flies, etc., it is possible to drive the insects from any particular animal by mechanical devices or by use of repelling odors. The second, *destructive*, where it is necessary by use of substances fatal to the parasite to cause its death. In all of these there is choice among a number of fairly successful measures, each of which may have some particular advantage under certain circumstances. For example, dips and washes, which may be safe enough in hot weather, may be undesirable in winter. On this account it has seemed that some method of fumigation might prove of value, and experiments in this line have been made which show that it can be used effectively. The time required, however, to do this makes other methods still preferable. Doubtless some improvements in details of application may much facilitate treatment in this manner, and we would call attention to the subject discussed more fully in Chapter VII.

CHAPTER II.

DIPTERA.

Mosquitoes, Gnats, Flies, and Ticks.

The insects of this group are readily distinguished by their having only one pair of wings, the second pair, common to other insects, being represented by a pair of rudiments or modified structures called halteres or balancers. In many of the parasitic forms, however, the wings are entirely wanting, as in the sheep-tick, spider-fly, etc. They have suctorial mouthparts, and, in the forms attacking the various animals, these parts become readily adapted to penetrating the skin to reach the small bloodvessels.

The larvæ are fleshy grubs or maggots, or slender worms, adapted in the different families to widely different conditions of existence, but in nearly all cases requiring some degree of moisture. In this respect they range all the way from the entirely aquatic mosquito larvæ to the forms which mature in comparatively dry situations in earth or even upon plants.

The pupæ are in some cases formed by the simple contraction and hardening of the larval skin and in disclosing the imago may either split on the dorsal surface or in a circular manner so that a cap is separated from the head end, leaving a round aperture through which the adult emerges.

While comparatively few are parasites in the strictest sense, the group includes many of the most troublesome of the insect enemies of live stock, as will be recognized in the discussion of particular species.

Family CULICIDÆ.

(Mosquitoes, Gnats, etc.)

The members of this family are slender-bodied, delicate insects with gauzy wings, the veins of which bear minute scales. The mouth parts are provided with lancet-like piercing mandibles which, in the females, are capable of inflicting a severe bite.

The larvæ in those species whose life history has been traced are aquatic, and this may doubtless be considered as the usual habit for the family; but it is very probable that many species pass through their transformations in moist places, under grass, etc., and perhaps even in tolerably dry situations. Otherwise it is difficult to account for the swarms of the adults in localities remote from water or low land.

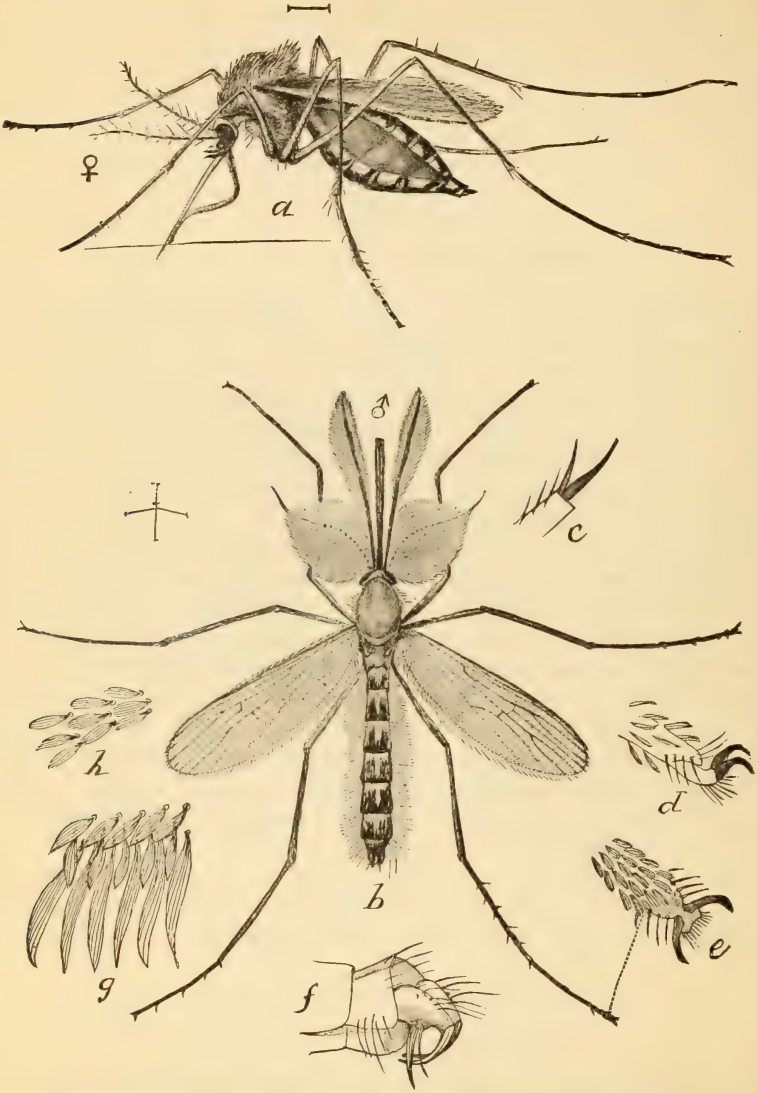

FIG. 1.—*Culex pungens:* *a*, female, from side; *b*, male, from above; *c*, front tarsus of same; *d*, middle; *e*, hind tarsus; *f*, genitalia of same; *g*, scales from hind border of wing; *h*, scales from disk of wing—all enlarged (from Howard).

The life history has been often repeated in works on natural history and it is unnecessary to give it in detail here. It may, however, be allowable to give a brief statement of the general course.

Eggs are deposited in small boat-shaped masses and the larvæ hatching from these escape into the water. They move about by a jerky motion, often ascending to the surface to obtain a fresh supply of air which is taken through a slender tube at the caudal end (fig. 2). The pupæ are also active and move about in the water during their brief existence in this form, rising to the surface for air, which is taken through a spiracle near the head When the insect is ready to emerge the pupa rests at the surface with the dorsal face slightly out of the water, the case splits and the mosquito draws out first the front legs which are placed on the water to serve as support while the rest of the body is withdrawn. The wings expand very quickly and the insect flies away.

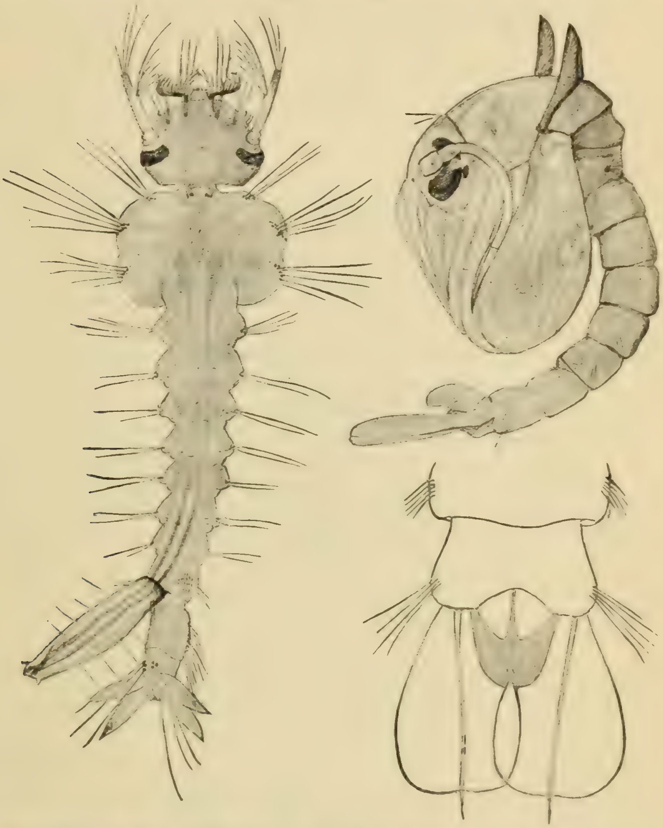

Fig. 2.—*Culex pungens:* larva at left, pupa at right, with anal segment below—all enlarged (from Howard).

About one hundred and fifty species of this family have been described, and of these over thirty belong to North America. They are mostly divided among the genera Culex, Anopheles, and Corethra, the majority, however, twenty-seven accredited species, being included in the genus Culex. These may be considered as mosquitoes proper, and all our most annoying forms.

Their aggravating habits have been recognized by describers in such significant names as *molestus*, *pungens*, *punctor*, *damnosus*, *excitans*, *excrucians*, *impatiens*, *implacabilis*, *provocans*, etc., which may be taken as indicating that even a naturalist is capable of harboring resentment.

Of the American species, *Culex pungens* has been studied in the Division of Entomology, and Dr. Howard has published in Circular No. 13, second series, a brief statement of its life history, being a condensed statement of a fuller article published in Bulletin No. 4, of this series.

The following quotation, however, with the beautiful figures which have been kindly placed at my disposal for this paper, will serve to give a clear idea of the habits upon which remedial measures must be based:

> The following statement concerning the life history of these insects is based upon a series of observations made in this Division upon the development of two summer generations of *Culex pungens*, one of our commonest and most widespread species. The writer has seen specimens of this insect from New Hampshire, Massachusetts, New York, Maryland, District of Columbia, Illinois, Minnesota, Kentucky, Nebraska, Louisiana, Georgia, and the Island of Jamaica, West Indies. No doubt it is also abundant in New Jersey.
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> Egg laying takes place at night. The eggs are deposited in boat-shaped masses on the surface of the water, the number varying from 200 to 400 in each mass. The eggs may hatch in sixteen hours. The larvæ live beneath the surface of the water, coming to the top at frequent intervals to breathe. The larval state may be completed in seven days; the pupal state may last only twenty-four hours. An entire generation in summer time, then, may be completed in ten days. This length of time, however, may be almost indefinitely enlarged if the weather be cool. There are, therefore, many generations in the course of a season, and the insect may breed successfully in a more or less transient surface pool of water.
>
> Mosquitoes hibernate in the adult condition in cellars and outhouses and under all sorts of shelter. The degree of cold makes no difference in successful hibernation; mosquitoes are abundant in the arctic regions.

PREVENTION AND REMEDY.

That cattle and horses suffer a great amount of pain, and that there is actual loss to the stock owner from this source will scarcely be called in question by anyone familiar with the subject. These animals may often be seen with a flock of the pests flying around them or located on the body, their distended blood-red abdomens attesting their sanguinary meal. This will be particularly noted where animals have been pastured in lowland or near thickets, where mosquitoes abound. That much can be done to abate this loss and pain is now well established, and the following extract from an article by Dr. L. O. Howard, who has done more than anyone else to call attention to these possibilities, will cover the question of remedies better than any summary of my own:

> Of remedies against mosquitoes in houses the best is a thorough screening of windows and the placing of nets about beds. If the insects are troublesome in sitting or sleeping rooms during the evening the burning of pyrethrum will so stupefy them as to make their presence unobjectionable. Pyrethrum for this purpose should be prepared by moistening the powder sufficiently to allow of its being roughly molded

by hand into little cones about the size and shape of a large chocolate drop. These cones are then placed in a pan and thoroughly dried in an oven. When fired at the apex such a cone will smolder slowly and send up a thin column of pungent smoke not hurtful to man, but stupyfying to mosquitoes. In actual experience two or three such cones burned during the course of an evening have given much relief from mosquitoes in sitting rooms. It does not kill the insects, however, and is at best but a palliative.

The mosquitoes found on the ceilings of bedrooms in the evening may be quickly and easily killed by means of a small, shallow tin cup (such as the lid of a blacking box) nailed to the top of a stick and wet inside with kerosene. This cup is placed over the quiescent mosquito, which immediately drops or flies against the oily surface and is killed. But altogether the most satisfactory means of fighting mosquitoes are those which are directed to the destruction of the larvæ or the abolition of breeding places. These measures are not everywhere feasible, but in many places there is absolutely no necessity for the endurance of the mosquito plague. The principal remedies of this class are three: The draining of ponds and marshes, the introduction of fish into fishless pools, and the use of kerosene on the surface of the water.

The draining of breeding pools needs no discussion. Obviously the drying up of such places will prevent mosquitoes from breeding therein, and the conditions of a successful application of this measure will, it is equally obvious, vary with each case.

The introduction of fish into fishless ponds is feasible and advisable in many cases where the use of kerosene on the surface of the water would be thought undesirable. In tanks supplying drinking water, for example, fish would destroy the mosquito larvæ as fast as hatched. A case is recorded in Insect Life (Vol. IV, p. 223) where carp were employed in this way with perfect success by an English gentleman living in the Riviera. At San Diego, Tex., the people use for this purpose a little fish, called there a perch, the species of which the writer has not been able to ascertain. Probably the common voracious little stickle-back would answer admirably as a mosquito destroyer.

Probably the best, and certainly the easiest, of wholesale remedies against mosquitoes is the application of kerosene to the surface of breeding pools. The suggestion that kerosene could be used as a remedy for mosquitoes is not new and has been made more than once. Exact experiments out of doors and on a large scale were made in 1892 by the writer. These and subsequent experiments show that approximately 1 ounce of kerosene to each 15 square feet of water surface on small pools will effectually destroy all the larvæ and pupæ in that pool, with the additional advantage that the adult females, not deterred from attempting to oviposit, are killed when they alight on the kerosene-covered water. Ordinarily, the application need not be renewed for a month, though varying circumstances may require more frequent applications in certain cases.

Since 1892 several demonstrations, on large and small scales, have been made of the practicability of this method. Under the writer's supervision two localities were rid of mosquitoes by the use of kerosene alone. It will, however, probably not prove feasible to treat in this way the large sea marshes along the coast where mosquitoes breed in hordes, although even here the remedy may prove to be practicable under certain conditions and in certain situations. In inland places, however, where the mosquito supply is derived from comparatively circumscribed pools, the kerosene remedy will prove most useful. In some California towns, we are informed, the pit or vault behind water-closets is subject to flushing with water during the irrigation of the land near by. A period of several weeks elapses before more water is turned in, and in the meantime the water in the pit grows stagnant and becomes the breeding place of thousands of mosquitoes. Where, as in certain towns and cities, house drainage runs into such a pit and an outdoor privy with a seldom closed door is built over it, mosquitoes will breed all summer in the fluid contents of the vault, and of course will infest all the adjacent houses.

In such cases a teacupful of kerosene poured into each vault at intervals of a month or less, would greatly decrease the annoyance from mosquitoes, if it did not altogether prevent it. This is a case where the cooperation of neighbors is most essential; every householder in a given neighborhood should see that his vault is treated with kerosene regularly and often. The cost is so trifling that it need not be considered.

When, as is the case at many country homes, rain water is collected in barrels or hogsheads, for one purpose or another, mosquitoes may and do breed in numbers in such vessels. If the water as used be drawn from the bottom of the cask, it will do no harm to pour in a little kerosene, since the oil will not be drawn out with the water. At all events, such receptacles should be covered at night to prevent egg laying.

The question what is the best way to cover with kerosene the surface of a pool of some size is apparently needless, since the operation is obviously simple, but such a question has been asked of the Division. Simply pouring the oil on from any point of the shore will answer tolerably well, since it will spread of itself, but if for any reason it is desired to coat the pool rapidly with kerosene, it may be advisable to spray the oil through a spraying nozzle, either from the bank or from a boat. The method of application will vary with each case, but in the class of pools which can be most advantageously treated, namely, those of small size, the oil can be well spread by throwing it on to windward with a wide sweep of the arm.

Family CHIRONOMIDÆ.

(Midges.)

The insects of this family are mosquito like, but differ, in that the costal vein is not continued around the wing. The antennæ of the males are usually plumose. The larvæ breed in still water, and for a species which has been present in great numbers in the water mains of Boone, Iowa, and which occurs in water tanks and reservoirs, it has been determined that the larvæ form a protecting tube of earthy particles and bits of organic matter, the pupæ coming to the surface to permit the emergence of the adult (Bull. 32, Iowa Exp. Sta.).

THE BLOOD-SUCKING GNAT.

(*Tersesthes torrens* Towr .)

This species, described from western New Mexico, is the type of a new genus, Tersesthes (Psyche, Vol. VI, p. 369). These gnats, according to Townsend, occurred in some numbers upon horses, mostly on the head and face, particularly around and below the eyes of the animals. They were very small and black, but their abdomens being distended and swollen with blood gave them a red appearance. The locality where they were taken was at an altitude of "something over 7,000 feet." This species has not been recorded from any other locality and would seem to have a restricted range.

It is described as being $1\frac{3}{5}$ mm. to $2\frac{1}{5}$ mm. long, according to the distension of the abdomen, the wings $1\frac{1}{5}$ mm., the general color blackish, wings grayish, transparent, with barely a smoky tinge. For further details the original description should be consulted.

Family SIMULIIDÆ.

(Black Flies, Buffalo Gnats.)

The insects of this family are short and small, thick bodied, having no simple eyes and no transverse suture in the thorax. They are seldom more than a quarter of an inch in length.

The larvæ, so far as known, all live under water, usually in swiftly running water, and their structure and habits are both peculiar. The following extract sums up the facts regarding the discoveries of early stages:

Schönbauer first discovered that the early stages of the Columbacz midge, egg, larva, and pupa, were passed in the water and only left that element to transform to the perfect insect. Some time afterwards Verdat and Fries published the transformations of the *Simulium sericeum*. The larvæ of the latter species live under the surface of the water on the stems of water plants on the genera Phellandrium and Sium.

The larvæ are slender, cylindrical, and furnished near the mouth with two singular flabelliform appendages arising in pairs. The posterior part of the body is inclosed in a semioval cocoon attached to the plant. The pupæ have on each side of the thorax eight long filiform appendages rising in pairs. The posterior part of the body is inclosed in a semioval cocoon attached to the plants. The fly issues below the surface of the water, and, rising to the top, is protected by a fine silky covering of hairs.

The early stages of several of the American species have been studied. In the American Entomologist (Vol. II, p. 227, June, 1870), under the heading, "The death web of young trout," we described the larva and pupa, with figures of a species afterwards described by us as *Simulium piscicidium* (ibid., p. 367). These larvæ were said by Seth Green to live attached to stones in swift running water and to spin a silken thread in which young fish became entangled and killed. This statement created much excitement among fish culturists at the time, and really seemed very plausible. It was contradicted, however, by Sara J. McBride, of Mumford, N. Y., in an article published in the same volume (pp. 365–367), and also by Fred Mather, of Honeoye Falls, N. Y., in private correspondence with us. Mrs. McBride found that the perfect flies issued about the 1st of April and the 1st of June thereafter the larvæ were found in the streams in great numbers—as a general rule attached to water plants 3 or 4 inches below the surface of the water. Some were also attached to stones at the bottom. The majority were fastened to green, decaying water cress, and these were green in color, while others which held to dead forest leaves of the previous year's growth, which had become entangled with the cress, were brown. From this fact she justly argued they fed upon decaying vegetation. There was a succession of generations or broods throughout the season, the development of a single brood occupying about two months. The flies issuing in midsummer were smaller than those developed in the spring and fall, although no difference in the size of the larvæ and pupæ was perceptible.

In the same volume (pp. 229–230), Osten Sacken gives an account of an undetermined species found attached to the roots and plants in swift running streams in the vicinity of Washington. This article contains also an able review of previous writings on the subject, and is illustrated with figures taken from Verdat.

In the American Entomologist (Vol. III, pp. 191–193, August, 1880), Dr. W. S. Barnard described the stages, with figures of the eggs, of a common species in the mountain streams around Ithaca, N. Y. The eggs were found on the rocks on the banks a few inches above the surface of the water; the newly hatched larvæ were just at the surface, and from this point there was a regular gradation in the size of the larvæ down into the stream. The eggs were found abundantly on the 1st of June.

In the Proceedings of the Boston Society of Natural History for January, 1880, Dr. Hagen described *Simulium pictipes*, a remarkably large species, the larvæ and pupæ of which were found in the rapids of the Au Sable River, Adirondack Mountains, and in mentioning the fact in the American Naturalist for April, 1881, we stated that the larvæ and pupæ of presumably the same species were found by Messrs. Hubbard and Schwarz in the rapids of Michipicoten River, north shore of Lake Superior. The larvæ were there found to have the peculiarity of floating in long strings, attached to each other by silken threads, while the pupæ, found in the quieter pools close by, resembled clusters of coral.

We also hazarded the statement that these were the immature forms of the celebrated black fly of the Lake Superior region. In reference to the probable identity of the Adirondack with the Lake Superior species, Dr. Hagen, in comparison of the specimens of these larvæ and pupæ, received from Mr. Hubbard, with similar stages of *S. pictipes*, remarked (Canadian Entomologist, Vol. XIII, pp. 150, 151) that while the larvæ and pupæ did not differ materially, imagoes from the Lake Superior, not raised from the pupæ collected by Mr. Hubbard, differed from *S. pictipes* in their much smaller size and in the color of the legs. (Report of the United States Entomologist for 1884, pp. 342–343.)

The report of the Entomologist for 1886 contains detailed accounts of the life history of two species named respectively the Southern buffalo-gnat and the turkey-gnat. The recent appearance of this report and its accessibility to all render it unnecessary to give more than a brief synopsis of these species, which will be added in their proper places.

LOSSES FROM BUFFALO GNATS.

The injuries caused by buffalo gnats are among the most serious resulting from insect attack on domestic animals and man. Since it is impossible to refer all such injuries to the species causing them, a statement of the losses due to the species collectively will be in place here.

The famous Columbacz midge has kept up its yearly attacks upon the stock in its respective locality for more than a century, according to authentic records, and so late as 1880 has caused, according to a report from Minister John A. Kasson, the loss of 158 buffalo, 186 oxen, 175 cows, 56 calves, 49 sheep, 118 horses, and 1,137 hogs. (See Report U. S. Commissioner of Agriculture, 1884, p. 341.)

In this country the losses from the species in the Northern States, though by no means inconsiderable, have not been such as to bring out accurate statistics. In the South the losses of sheep, hogs, poultry, cattle, horses, and mules have been very great, but approximate estimates are given in only a few cases.

As far as can be learned the damage in Louisiana was but slight prior to 1850; but many animals were killed in 1861, 1862, 1863, 1864, and 1866. In this latter year the parish of Tallulah, La., lost over 200 head of mules, and upward of 400 mules and horses were killed within a few days in the parishes of Madison, Tensas, and Concordia, all in the same State. In other States they also did great damage. In 1868 many mules were killed in the lowlands of Daviess County, Ky. Although frequently causing more or less trouble and loss, they did not appear again in such overwhelming numbers until 1872, 1873, 1874, 1881, 1882, 1884, 1885, and 1886. In 1872 it was reported that the loss of mules and horses in Crittenden County, Ark., exceeded the loss from all diseases. In 1873 they caused serious injury in many parishes of Louisiana. In 1874 the loss occasioned in one county in southwest Tennessee was estimated at $500,000. The gnats have been especially injurious since the Mississippi floods of 1881 and 1882; in the latter year they were more destructive to stock than ever before, appearing in immense numbers in eastern Kansas, western Tennessee, and western Mississippi, and the great destruction of cattle, horses, and mules caused by them added greatly to the distress of the inhabitants of those sections of the country caused by unprecedented floods. Many localities along the Mississippi River in Arkansas also suffered severely. In 1884 buffalo-gnats appeared again in great numbers and were fully as destructive as in 1882. In Franklin Parish, La., within a week from their first appearance, they had caused the death of 300 head of stock. They were equally numerous throughout the whole region infested, and for the first time in the history of the pest they attacked horses and mules on the streets of the cities of Vicksburg and Memphis. No general outbreak took place in 1885, yet gnats appeared in sufficient numbers to kill quite a number of mules in various parishes of Louisiana, especially in Tensas and Franklin. Buffalo-gnats appeared again in immense numbers in 1886, and extended throughout the entire lower Mississippi Valley, and swarms were even observed and doing damage far away from the region usually invaded. They came very late in the season, and consequently animals were in better condition to withstand their attacks. The damage was great, however, in many localities where planters had not taken steps to protect their stock.

Besides the actual loss by death of their stock, planters lose much valuable time in preparing their fields for the crops. It so happens that the gnats appear at a time in which the ground becomes fit to be prepared for cotton, and as it is very important to give that plant as much time as possible to mature, every day is very valuable in early spring. Planters owning large estates have to use their mules for plowing, notwithstanding the gnats, while farmers on a small scale can keep their animals in the stable, thus protecting them. (Report United States Department of Agriculture, 1886, p. 502.)

LIFE HISTORY AND HABITS.

The eggs have been discovered for but comparatively few species. Dr. W. S. Barnard describes and figures those of a species found at Ithaca, N. Y. (American Entomologist, Vol. III, pp. 191–193):

These eggs (fig. 3) were found on the rocks on the banks a few inches above the surface of the water, and we give herewith a description of them as a means of facilitating the finding of those of other species. The eggs are deposited in a compact layer. Their shape is long ovoid, but on account of their softness and close proximity to each other they become distorted and polyhedral. One end is frequently flattened or concave. Each egg measures 0.40 by 0.18 mm. In Hungary the eggs of the Columbacz midge (*S. columbatczense* Schönbauer) have also been studied by Edward Tomosvary, and the observations have been published since his death by

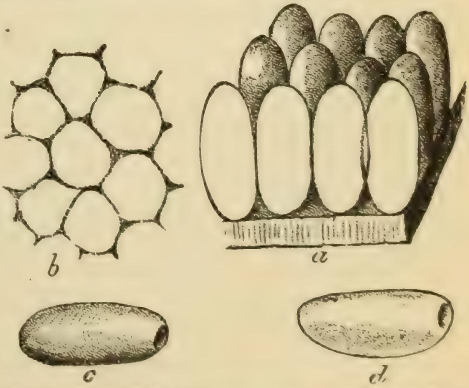

FIG. 3.—Eggs of Simulium—much enlarged (after Barnard).

Dr. Geza Horvath.[1] Its eggs, which are enveloped in a yellowish-white slime and deposited toward the end of May or beginning of June, are also deposited upon stones or grass over which the water flows and in the brooks of the more elevated regions. The female of that species is said to deposit on an average from 5,000 to 10,000 eggs, but no detailed description is given, while we have found only about 500 in the ovaries of our species.

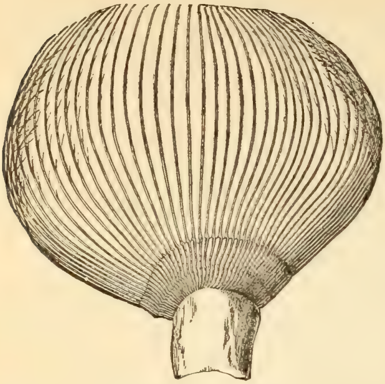
FIG. 4—Fan of *Simulium pecuarum*—greatly enlarged (from Riley).

The larvæ are generally less than half an inch in length, subcylindrical, attenuated in the middle, and enlarged toward both ends; the posterior third of the body is much stouter than the anterior third, and almost club-shaped. The color of the larva varies greatly, and is usually more or less like that of the substance upon which it is fastened. The head, which is generally nearly square, is marked with a pair of small, black, approximate spots on each side that look like eyes, but are not. Beside the usual mouth organs, the head possesses two additional brown and fan-shaped bodies, which are usually spread out and kept in constant motion when catching food; they open and close like a fan, and if folded can be partially withdrawn into the mouth. The smooth body of the larva is composed of twelve joints or segments, five of which form the club-shaped anal portion of the body. On the under side of the thoracic portion is a subconical, retractile process (fig. 5), crowned with a circular row of short and sharp bristles. The anal extremity consists also of a subcylindrical, truncated protuberance, which is crowned with rows of bristles similar to those of the thoracic proleg. The larva possesses no stigmata, but immediately below the anal protuberance, on the under side of the body, there are three short, cylindrical, soft, curved, and retractile tentacles, to which the large tracheæ lead, and which are probably the organs of respiration. * * *

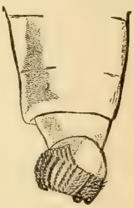
FIG. 5.—Proleg of *S. pecuarum*—greatly enlarged (from Riley).

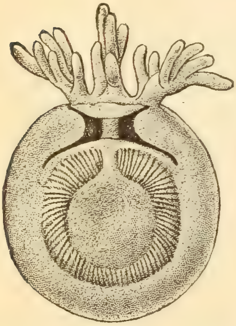
FIG. 6.—Breathing organs of *S. meridionale*—greatly enlarged (from Riley).

In some of the most mature larvæ two kidney-shaped black spots are visible just above the thoracic proleg, one on each side. If closely investigated with a good lens, it is seen that the tufts of filaments serving the future pupa for respiration are already formed under the larval skin. All these filaments arise from the same spot and are branches of a single internal tube. * * *

The most essential condition for the well-being of these aquatic creatures is rapid motion of the water in which they live. * * * The next important condition of a suitable breeding place is the presence of some stationary material in the water upon which to fasten themselves. * * * Water in rapid motion is found only in certain, well-defined places, either in streams coming from an elevated plateau or in streams meandering through a level country. In the former any sudden bend, or declivity, and any obstruction, no matter how small, will produce accelerated motion of the water. In the latter sudden bends are the chief cause. In the former there are numerous places where the larvæ can securely fasten themselves, because large numbers of sticks partly embedded in the mud are not disturbed by the rising water.

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[1] A. Kolumbácsi légy, Dr. Horváth Géza, in Rovartani Lapok, Vol. I, No. 10, Budapest, 1884.

In many places the rocky beds of streams furnish excellent support for certain species. In such places as these they occur more or less in clusters, fastened by the posterior end of the body and capable of considerable movement, by traveling with a looping gait, by attaching themselves with silken threads and then allowing the current to move them about, or by floating free with the current until finding a satisfactory place in which to fasten again.

The food of the larvæ has not been determined for many of the species, but the Southern buffalo gnat has been proven to be carnivorous, and in all probability other species have a similar habit.

The pupa of the species of Simulium is peculiar and distinguished from most other dipterous pupæ by the presence of a tuft of respiratory filaments starting from each side of the thorax. (See figures of pupæ of *Simulium pecuarum* and *meridionale.*) These tufts are composed of a variable number of very slender filaments varying with the different species of Simulium. The abdomen is armed with spines, and at the tip are two larger bent spines or hooks by which the pupa anchors itself within the pouch-like cocoon. This cocoon is open at the upper end and allows the exposed head portion of the pupa bearing the respiratory filaments to have free access to the water. It is composed of silken threads, generally grayish in color, and is attached firmly to sticks, leaves, logs, or other objects in the current of water.

Remaining but a very short time in the pupal state, prolonged or shortened by atmospheric influences, they give forth the winged insects. The length of the pupal state in the case of the turkey-gnat averages five days. Both larval and pupal skins remain for some time in the empty pouch.

The perfect insects issue from their pupæ under water, and surrounded, according to some writers, by a bubble of air. The silky hairs of the fly, however, are protection enough to prevent it from drowning. The winged insect pops to the surface like a cork, runs a few inches over the water, and darts away with great swiftness.

The imago.—The perfect flies vary in length, the females being usually the larger. They are characterized by their peculiar short and thick shape. The head is bent under, and is nearly as wide as the very large and humped thorax. The thick antennæ are composed of twelve stout joints; the four-jointed palpi terminate in long and fine joints; the posterior shanks and the first joint of the hind tarsi are somewhat dilated. The free labrum is as sharp as a dagger, and the very prominent proboscis is well adapted for drawing blood. The insects possess no ocelli, but their eyes are large; in the male they join at the forehead, but in the female they are farther apart. The mouth organs of the male are also not so well developed as in the female, being soft and unable to draw blood. The bodies of these gnats are quite hard and can resist considerable pressure. * * *

The gnats are exceedingly active, and endowed with very acute senses, which enable them to find unerringly animals a long distance away. Only females seem to form these aggressive swarms, since not a single male has been found in the large numbers captured and investigated. The male stays near the place of its birth, and since females once gorged with blood do not and can not return, copulation and the depositing of eggs must take place very soon after emerging from the water. These points have as yet to be investigated.

All species of the genus Simulium, the life histories of which have been studied, are single-brooded. * * *

PREVENTIVES.

Smudges have thus far proved the best method of protecting animals in the field against buffalo-gnats. Thoughtful planters are in the habit of collecting and storing during the year all kinds of material that will produce a dense and stifling smoke; such materials are old leather, cast-off clothing, dried dung, etc. As soon as large swarms of gnats appear, and the stock is threatened by them, fires are started in different parts of the plantation, and are kept burning as long as the danger lasts. Anything that will produce smoke is thrown upon the smoldering logs, and the most offensive is considered the most useful. If the time for plowing has arrived, smudges are located in the fields in such a manner that the smoke is drifted by the wind over the teams at work. Such smoke-producing fires are also kept burning in the cities, and they are found in front of every livery and street-car stable, as well as of such stores as employ draft horses or mules. If these animals have to be upon the roads, they may usually be somewhat protected by tin pails in which some smudge is kept, and which are suspended from their necks and from the wagons.

Animals may also be protected with a layer of mud or a coat of sirup. It has been found that animals which have shed their rough winter coat of hair and have become smooth are not as much troubled as others still covered with long hairs. The gnats find it much more difficult to obtain a foothold upon a smooth skin, and the clipping of the hair in early spring is therefore advisable.

Buffalo-gnats have a great aversion to entering dark places, and stables thoroughly darkened are safe places for stock of all kinds in a gnat season. The odor of ammonia prevailing in such stables may also to some extent prevent the insects from entering. Planters with a small acreage, therefore, prefer to keep their horses and mules in the stable instead of working them in the field. For the same reason the owners of livery stables will not allow their animals to be taken outside the city limits if gnats are numerous enough to be dangerous.

But the great majority of planters can not wait for the disappearance of the pest, and have to resort to other defensive means. Various external applications have been used to this effect: Decoctions of alder leaves, tobacco, pennyroyal, and other herbs, have been tried with a view of preventing gnats from biting mules while at work; but all of them have proven ineffective. At a time when small swarms of turkey-gnats were tormenting mules plowing in the field one side of the animal was moistened by Mr. Lugger with various insecticides, while the other side was not protected at all. By following the animal and watching the gnats it was soon observed that any offensive smelling substance would drive the gnats from the protected side to the unprotected one. Kerosene emulsion, pyrethrum powder suspended in water, diluted carbon-bisulphide, and dissolved tobacco soap were all used in turn, and all seemed to produce the same effect. Several times the whole animal was carefully sponged with the one or the other of the above substances. For a time the gnats would not settle upon the animal; but in the course of two hours the beneficial effect of these insecticides was gone and the insects were no longer kept away.

Experience shows that the best preventive is grease of various kinds. The following kinds are the most important: Cotton-seed oil alone, or mixed with tar, fish oil, gnat oil; a combination of stinking oils alone, or mixed with tar or kerosene oil, crude coal oil, kerosene oil, kerosene oil mixed with axle grease, and others. To be effective, the grease must be used at least twice during the day, because as soon as its offensive odor disappears it becomes inoperative. All such applications are of no advantage, however, on stock running at large. Gnat oil is very extensively used, but it is, like the rest of the remedies, very apt to remove the hair.[1] In fact, all these different kinds of oil and grease are more or less injurious to the animals, because a continued coating with them weakens the system.

The employees of the Hudson's Bay Company protect themselves and their stock against the bites of the "black fly" by the use of oil of tar, and as long experience has shown it to be a simple and easily applied wash, we strongly recommend its use. A quantity of coal tar is placed in the bottom of a large shallow receptacle of some sort, and a small quantity of oil of tar, or oil of turpentine, or any similar material, is stirred in. The receptacle is then filled with water, which is left standing for several days until well impregnated with the odor. The animals to be protected are then washed with this water as often as seems to be necessary.

As long as stock in the infested region is suffered to run at large, and is neither provided with shelter nor food during the winter months, it will suffer severely from the gnats. Animals well cared for can stand the attacks of the gnats far better, and do not perish as readily. Illtreated and unhealthy mules and those bruised and cut are the first to die, and the prevailing opinion of intelligent planters is to the effect that well-cared-for mules, if greased twice a day when working in the field, seldom die even when attacked.

In each infested district it should be made an object of special investigation to discover the breeding grounds; to determine the place and manner of egg deposition and other points in the life history since it is probably from this direction that we must expect to discover some plan by which to destroy the pests in the immature stages and thereby prevent the appearance of the vast swarms of flies which produce such serious consequences.

REMEDIES FOR THE BITES.

A number of remedies to counteract the poison of the buffalo-gnats have been tried, but none of them have been sufficiently tested or have proven uniformly effective. The following applications have been of sufficient use to merit further trial: (1) Rubbing with water of ammonia, and administering internally a mixture of 40 to 50 grains of carbonate of ammonia to 1 pint of whisky, repeating the dose every three or four hours until relieved; (2) continued doses of whisky alone and keeping the animal in a cool and darkened stable; (3) immersion in cold water of running streams.

Many cases of death of human beings from the bites of buffalo-gnats have been reported and some of them seem well authenticated. The painfulness of their attacks will certainly put people on their guard, but it would be well for persons in localities subject to invasion to go prepared with some means of protecting themselves when far from shelter during the season of the year when the flies abound.

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[1] According to Messrs. Fahlen & Kleinschmidt, chemists, of Memphis, Tenn., "gnat oil is any kind of stinking oil; it should not contain drying oils, such as *Oleum lini* and *O. gossypii.*" They use fish oil, and to increase its perfume add *Ol. animale fœtidum*, 4 ounces to 10 gallons. But since fish oil costs 50 to 75 cents per gallon, some mix it with crude petroleum; this addition, however, has the tendency to kill the hair roots. *Ol. hedeomæ* (pennyroyal) is too costly, and therefore not frequently used. Fish oil and *Ol. animale fœtidum* have given the best satisfaction.

NATURAL ENEMIES OF BUFFALO GNATS

The adults have so far appeared but little subject to attack from other animals. But few birds have been observed to feed upon them, though for the Southern forms the mocking bird, winter wren, and especially barnyard fowls, after the flies become gorged with blood, feed upon them Dragon flies (Libellulidæ) and robber flies (Asilidæ) have been observed to catch them.

The larvæ are devoured in large numbers by the smaller fishes, minnows, etc.; and probably the carnivorous beetles, bugs, and other aquatic insects prey upon them. Dr. Howard has observed near Washington the larvæ of a species of Hydropsyche feeding upon the larvæ of a species common in that locality.

The pupæ are pretty well protected by the resemblance in color to the objects to which they are fastened and their quiet habits. The eggs would seem to be open to the attacks of fishes, carnivorous beetles, etc., but no positive observations seem to have been made.

DESCRIPTIONS OF SPECIES WITH NOTES ON THEIR HABITS.

The species of this family, though not extremely numerous, have not been very fully characterized, and it is with difficulty that they are defined in brief terms. The attempt here is to enumerate the species so far clearly established, but more particularly to present the habits of each as related to domestic animals, without entering upon anything like a monographic treatment of them.

THE COLUMBACZ MIDGE.

(*Simulium columbatczense* Schönbauer.)

This, the first species to be studied in detail, was fully described by Ch. Schönbauer[1] nearly a century ago, and has been discussed by Kollar and others at various times since. The past history of the species, its distribution, destructiveness, etc., have already been stated.

Its distribution extends over the valley of the Danube, though particularly marked in the region of Columbacz, and some authors believe its distribution to be quite general and many other species to be but synonyms.

Kollar[2] says "a small fly, the length of which scarcely reaches 1½ lines and its breadth half a line, is one of the greatest scourges of the Banat of Temesvar, particularly that part situated between Uypalanka and Ursowa, which borders on the Danube."

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[1] Geschichte der schädlichen Kolumbatczer Mükken im Banat, Wien, Patzkowsky, 1795.

[2] Treatise on Injurious Insects, etc., pp. 68, 70.

"In the year 1830 there appeared in the end of April and beginning of May, after a previous overflowing in the month of March, the same notorious *Simulium columbatczense* as I was convinced by a close comparison on the shores of the marsh from its junction with the Danube as far as Hanna, in Austria-Hungary and Moravia, and most plentifully in the countries lying on the banks exposed to the inundations. It attacked cattle in the meadows as in the Banat, and the villages in that neighborhood lost some hundreds of cattle, such as horses, cows, and swine."

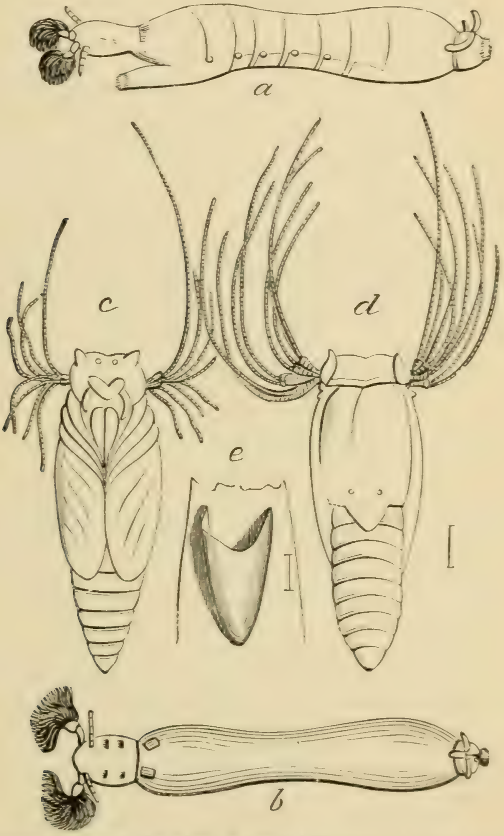

FIG. 7.—*Simulium ornatum*: *a*, larva, side view; *b*, same, back view; *c*, pupa, beneath; *d*, same, from above; *e*, cocoon—much enlarged (after Verdat).

Simulium reptans Linn. is considered by many authorities as equivalent to the *columbatczense*. It was described from Lapland previous to the description of *columbatczense*, and, if identical, should of course include the form referred to that species.

Simulium ornatum Meig.

This is the species upon which Verdat and Fries made the extended studies which have been mentioned in the fore part of this chapter under the name of *Simulium sericeum*. Baron Osten Sacken, however, states that he inclines to the opinion that it is in reality the *ornatum*, and in deference to this opinion we include mention of it under that name. It may be remarked that *sericeum* is considered the same as *columbatczense*, mention of which has already been made.

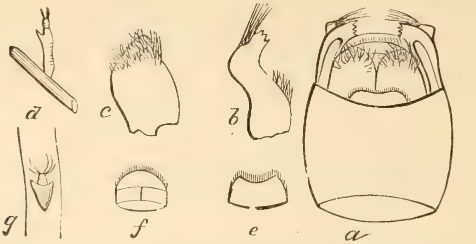

FIG. 8.—*Simulium ornatum*: *a*, head of larva, beneath; *b*, mandible; *c*, maxilla; *e*, under lip; *f*, upper lip—all enlarged; *d*, larva attached to plant; *g*, pupa in cocoon—natural size (after Verdat).

This species has not the record of having proven a source of any great annoyance in the region to which it is common, nor is its geographical limit given with precision in any work at hand. The studies of its larval and pupal stages, however, gave a foundation for later researches upon the subject, and as furnishing interesting subjects for comparison, we reproduce the figures published by Verdat.

THE BLACK FLY.

(*Simulium molestum* Harris, MSS.)

The celebrated black fly of the Northern States has long been known in the adult form as a torment to travelers and to domestic animals. The following account by Dr. A. S. Packard (Amer. Nat., Vol. II, pp. 589–590) is sufficiently characteristic:

> The black fly is even a more formidable pest than the mosquito. In the northern, subarctic regions it opposes a barrier against travel. The Labrador fisherman spends his summer on the seashore, scarcely daring to penetrate the interior on account of the swarms of these flies. During a summer residence on this coast we sailed up the Esquimaux River for 6 or 8 miles, spending a few hours at a house situated on the bank. The day was warm and but little wind blowing and the swarms of black flies were absolutely terrific. In vain we frantically waved our net among them, allured by some rare moth. After making a few desperate charges in the face of the thronging pests, we had to retire to the house where the windows actually swarmed with them; but here they would fly in our face, crawl under our clothes, where they would even remain and bite in the night. The children of the house were sickly and worn by their unceasing torments; and the shaggy Newfoundland dogs, whose thick coats would seem to be proof against their bites, ran from their shelter beneath the bench and dashed into the river, their only retreat. In cloudy weather, unlike the mosquito, the black fly disappears, only flying when the sun shines. The bite of the black fly is often severe, the creature leaving a large clot of blood to mark the scene of its surgical triumphs.

The distribution of this species is not accurately defined, but southward it occupies the mountainous regions of northern New England,

and it probably occurs in localities throughout much of the British provinces, its local distribution depending upon the occurrence of swiftly running streams, which are essential to the life of the larvæ.

The larval form has not been positively identified, but Dr. Packard figures a specimen which he collected in Labrador and which he supposes to be the larva of *molestum* or a closely related species.

THE SOUTHERN BUFFALO GNAT.

(*Simulium pecuarum* Riley.)

EARLY HISTORY.

In the American Journal of Science (Vol. I, 1818) there occurs on page 328, under the heading, "A destructive insect," the following interesting account, which must certainly refer to the buffalo-gnat, and which is, so far as I know, the earliest authentic account of its operations:

> But I will not enlarge upon a fact already familiar. I will ask your further indulgence only while I communicate an authentic and curious fact for the information of the zoologist.
>
> In the Choctaw country, 130 miles northeast of Natchez, a part of the public road is rendered famous on account of the periodical return of a poisonous and destructive fly. Contrary to the custom of other insects, it always appears when the cold weather commences in December, and as invariably disappears on the approach of warm weather, which is about the 1st of April. It is said to have been remarked first in the winter of 1807, during a snowstorm, when its effects upon the horses and cattle were observed to be similar to those of the gnat and mosquito in summer, except that they were more severe. It continued to return at the same season of the year, without producing extensive mischief, until the winter of 1816, when it began to be generally fatal to the horses of travelers. So far as I recollect, it was stated that from thirty to forty traveling horses were destroyed during this winter. The consequences were alarming. In the wilderness where the man's horse is his chief dependence, the traveler was surprised and distressed to see the beast sicken and die in convulsions, sometimes within three hours after encountering this little insect. Or, if the animal were fortunate enough to live, a sickness followed, commonly attended with the sudden and entire shedding of the hair, which rendered the brute unfit for use. Unwilling to believe that effects so dreadful could be produced by a cause apparently so trifling, travelers began to suspect that the Indians or others, of whom they obtained food for their horses, had, for some base and selfish end, mingled poison with it. The greatest precaution was observed. They refused to stop at any house on the way and carried, for the distance of 40 or 50 miles their own provisions, but after all suffered the same calamities. This excited serious inquiry into the true cause of their distress. The fly which has been mentioned was known to be a most singular insect, and peculiarly troublesome to horses. At length it was admitted by all that the cause of the evils complained of could be no other than this insect. Other precautions have since been observed, particularly that of riding over the road infested with it in the night; and it now happens that comparatively few horses are destroyed. I am unable to describe it from my own observation. I passed over the same road in April last, only two weeks after it disappeared, and was obliged to take the description from others. Its color is a dark brown. It has an elongated head, with a small and sharp proboscis, and in size between the gnat and mosquito. When it alights upon a horse it darts through the air, much like a gnat, and never quits its hold until removed by force. When a horse stops to drink swarms fly about the head and crowd into the mouth, nostrils, and ears;

hence it is supposed the poison is communicated inwardly. Whether this be true or not, the most fatal consequences result. It is singular that from the time of its first appearance it has never extended for a greater distance than 40 miles in one direction, and usually it is confined to 15 miles. In no other part of the country has it ever been seen. From this fact it would seem probable that the cause of its existence is local. But what it is none can tell. After the warm weather commences it disappears as effectually from human observation as if it were annihilated. Toward the close of December it springs up all at once into being again, and resumes the work of destruction. A fact so singular I could not have ventured to state without the best evidence of its reality. All the circumstances here related are familiar to hundreds, and were in almost every man's mouth when I passed through the country. In addition to this they were confirmed by the account which I received from Col. John McKee, a gentleman of much intelligence and respectability, who is the present agent of the General Government for the Choctaw Nation. He has consented to obtain specimens of the insect for your examination when it returns again; and will, I hope, accompany the transmission with a more perfect description than it has been possible for me to communicate.—REV. ELIAS CORNELIUS.

In the report of the United States Department of Agriculture for 1886, the following summary of early occurrences is given:

It seems that no authentic record exists in Louisiana about the occurrence of the Southern buffalo-gnat prior to the year 1850. It has been reported, however, that they had previously appeared in 1846. In 1861 and 1862 they were very troublesome in portions of Mississippi and Louisiana; in 1863 and 1864 they abounded about Shreveport, La., and in Chicot County, Ark. None are reported to occur in 1865, but in 1866 they invaded the alluvial country between the Arkansas and Red rivers east of the Washita. In 1873 and 1874 serious injury was occasioned by them in several regions in Louisiana. But in 1882 and 1884 they were more destructive than ever before, doing immense damage to live stock of all kinds. Although not generally very numerous in 1885, they appeared in sufficient numbers in several counties of Louisiana to kill quite a number of mules. In 1886 they appeared generally throughout the whole extent of the region infested by them, and they appeared rather unexpectedly, because it was so unprecedentedly late in the season.

In Indiana this insect was well known as far back as 1843, when the settlers used to watch for it every year, as swarms would appear in certain regions with more or less regularity, often occasioning considerable damage.

It was ascertained from a number of gentlemen in Tennessee and Mississippi that the buffalo-gnats were well known to their ancestors who first settled in that region at a time when Indians were their neighbors.

But everyone questioned in the States of Louisiana, Mississippi, Tennessee, and Arkansas would voice this universal opinion, viz., that buffalo-gnats come only with high water and are contemporary with an overflow. The connection between an overflow and the appearance of the buffalo-gnats will be considered farther on.

AREA INFESTED.

The investigations of 1885–86–87, which have been reported very fully in the Department publications and from which the statements here made are mostly compiled, have shown that the extent of territory invaded by these insects is much greater than formerly supposed. It may be stated to comprise, in the worst years, the whole of the Mississippi Valley from the mouth of the Red River, in Louisiana, to St. Louis, Mo. All the land adjacent to the many rivers and creeks that empty from the east and the west into the Mississippi River is invaded by swarms. They are driven about by the wind and reach points far away from their breeding places.

In Louisiana all the land inclosed by the Mississippi and Red rivers, with perhaps the exception of the extreme western counties, is usually invaded by the buffalo-gnats during a gnat year. South of the Red River they become scarce, less aggressive, and appear only at very irregular intervals.

In Mississippi all the counties bordering on the river that gives the name to the State are more or less invaded during gnat years.

All Arkansas, excepting perhaps the western counties, shares the same fate. In the numerous creeks and rivers of this State and of Louisiana the buffalo-gnat breeds most abundantly.

In Tennessee the same conditions prevail as in Mississippi, but the swarms do not reach so far east as in the latter State.

In Missouri the buffalo-gnats infest only the southeastern counties.

Kentucky does not fare as well as Missouri, since swarms of them frequently ascend the Ohio River for some distance.

Illinois and Indiana are also more or less invaded; in the former, it is the region bordering upon the Mississippi and Wabash rivers; in the latter, that on the Ohio and Wabash rivers. In 1886 buffalo-gnats appeared in large swarms at De Soto, in Jackson County, Ill., and along the White River, in Daviess County, Ind.

In eastern Kansas swarms have repeatedly done great damage.

LOSSES OCCASIONED.

The extent of the losses due to this species have already been stated, though it is of course impossible to separate the losses due to this species from those caused by the turkey-gnat. In a general way the latter may be said to be more destructive to poultry, while the attacks of this species are more particularly directed against the larger domestic animals.

Domestic animals are attacked in the following order, varying somewhat in different localities, viz, mules, horses, cattle, sheep, setting turkeys and hens, hogs, dogs, and cats. The death rate of mules is highest, both because they seem to be more susceptible to the bite, and because they are almost exclusively used in the Southern States for farm work. Horses also suffer greatly. Cattle, when weakened by winter exposure and by scarcity of food, succumb easily to the continued attacks of their winged foes. Hogs show at first the effects of the bite but very little; yet large numbers die soon after the attack, while others die about six weeks after the disappearance of the buffalo-gnats; they usually perish from large ulcerating sores, which cause blood poisoning. Many persons claim that the so-called charbon is produced by the bites of these gnats, a statement which is, of course, not borne out by facts. Sheep, although well protected by their wool, suffer greatly by bites upon the unprotected portions of their skins, and injure themselves still more by crowding too close to fires, which are built to produce protecting smoke. Many sheep crowd so close to the fire as to be burned to death. Setting turkeys and hens are frequently forced by the gnats to leave their nests. Young fowls are killed outright. The gnats, in attacking fowls of all kinds, force their way under the wings of their victims, where they can not be dislodged. Dogs and cats are also greatly tormented, and will not remain outdoors during a buffalo-gnat invasion if they can help it. Deer, forgetful of any other threatening danger, are tormented to such a degree as to lose all fear, and approach the smoldering fires; in their agony they sometimes allow people to rub the gnats from their bodies, and will, in their frantic endeavors for relief, even lie down in the glowing embers or hot ashes.

EFFECT OF THE BITES.

Animals bitten by many buffalo-gnats show all the symptoms of colic, and many people believe that these bites bring on that disease. Mules especially are thus affected, yet large numbers of post-mortem examinations made by Dr. Warren King, of Vicksburg, and others, failed to show any relationship between this disease and the bites, nor were any facts obtained which would justify the correctness of such a popular conclusion. Dr. King opines that the effects of these bites on animals are much the same as that of the rattlesnake on the human system. This seems to be the generally accepted opinion among the more intelligent planters. The animal attacked becomes at first frantic, but within a very short time it ceases to show symptoms of pain, submits passively to the infliction, rolls over, and dies; sometimes all within the space of three or four hours. Even if bitten by a very great number of gnats death does not necessarily follow, and then it is not always suddenly fatal. Mules which at night do not appear to be seriously injured will often be found dead next morning.

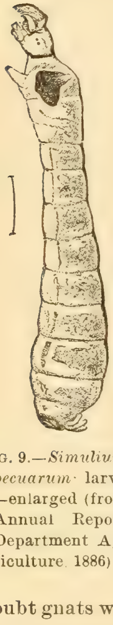

FIG. 9.—*Simulium pecuarum* larva—enlarged (from Annual Report Department Agriculture 1886).

Animals of various kinds become gradually accustomed to these bites, and during a long-continued invasion but few are killed toward the end of it. It is a prevailing notion that the bite of the gnats appearing first is the most poisonous. It would seem to be more probable, however, that the poison introduced into the systems of animals—unless sufficient to prove fatal—may to some extent serve as an antidote against that introduced later, and if this poison should remain in the system with any stability, such a fact would also account for native or acclimated stock being less susceptible to the poison from bites than that recently imported. There is no doubt that stock freshly imported from Kentucky to Tennessee and Mississippi is more apt to be killed than that raised in the infested portions of these States, and that, having withstood one invasion, a second one proves fatal but seldom. One reason why buffalo-gnats appearing very early in the season are more dangerous may be found in the fact that the stock, weakened by exposure during the winter, have had as yet no chance to gain in strength by feeding upon the early vegetation, which it obtains previous to and during a later invasion. Consequently, the resisting power of animals is greater later in the season. Experience has also taught owners of stock how to protect the same, and in comparison with former gnat seasons fewer animals are killed of late. Prof. J. A Schönbauer, who wrote nearly one hundred years ago about the Kolumbacz gnats of Hungary, witnessed the post-mortem examination of a horse killed by these gnats. Upon dissection it was found that not only was the anus entirely filled with the flies, but also the genital orifices, the nasal passages, and the bronchial tube and its ramifications. A case of this kind must be very exceptional. No doubt gnats will sometimes enter these passages, but as a rule death is not occasioned in this manner. The loss of blood and the terrible irritation of the skin by so many poisonous bites are reasons sufficient to account for the reflex irritation of the nerves and blood poisoning.

LIFE HISTORY AND HABITS.

The larva is not different in general appearance from that of other species and the general characters have already been stated.

The annexed cut (fig. 9) shows it considerably enlarged and will make a detailed description unnecessary. It is translucent when living; the body in some individuals is without markings, while in most it is distinctly marked with dark cross bands on the back in the middle of the joints, while at each side is a white space; the under side is more or less irregularly spotted with brown.

The head is yellowish brown, nearly square, horny, and marked as in the figure (fig. 10).

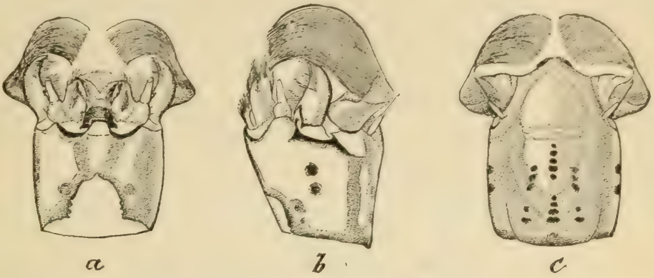

FIG. 10.—*Simulium pecuarum:* head of larva—*a*, beneath; *b*, side; *c*, above—greatly enlarged (from Annual Report Department Agriculture, 1886).

The tip of the abdomen is crowned with rows of hooks (see fig. 11) and on the upper side of the abdomen is the set of breathing organs, which have been mentioned heretofore.

The larvæ are found more particularly attached to submerged logs, wholly or partly submerged stumps, brush, bushes, and other like objects in the larger creeks and bayous of the region to which they are common.

They cluster together, and, fastened by the posterior protuberance to the leaf, they assume an erect position, or make their way upward and downward with a looping gait. Frequently attached by a minute thread, they sway with the ripples at or near the surface of the water, often as many as half a dozen being attached to a single thread. * * * They make their way up and down these objects with perfect freedom, but do not venture above the water.

Food of the larvæ.—The larvæ of the Southern buffalo-gnat are carnivorous in their habits, although they do not, perhaps, reject floating particles of a vegetable origin. Their mouth is not adapted for biting off any pieces from a large or solid substance, but is constructed to catch and ingulf small objects. To obtain these the fan-like organs peculiar to these larvæ create currents of water directed toward the mouth. Any small and floating matter drifted by the current of water into the vicinity of these fans is attracted by the ciliary motions of the component rays of the same, and thus reaches the space embraced by them, and they, bending over the mouth, direct the further motions of the particles. If of the proper kind they are eaten, otherwise they are expelled by a sudden opening or parting of the fans. They do not feed, as has been claimed, upon plants which they are unable to bite off or chew, and which do not exist in the water at the time when the larvæ grow most rapidly. A searching investigation of the water in their breeding places revealed the fact that it was swarming with animal life, and was filled with the larval forms of small crustaceans belonging to various families, but chiefly to those of Copepods and Isopods. An abundant supply of food must also be found in

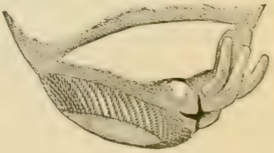

FIG. 11.—*Simulium pecuarum:* Tip of abdomen—enlarged (from Annual Report Department Agriculture, 1886).

the presence of immense numbers of fresh-water sponges, polyps, and animalcula. Larvæ of the Southern buffalo-gnat kept in glass vessels were observed to swallow these minute crustaceans, and none of this food was seen to be expelled again. A number of square diatoms, jointed together in a chain, have also been observed in the intestines of these larvæ by the aid of the microscope. The presence of such quantities of animal food will also account for the observed fact that the larvæ grow so very rapidly during the early spring, since this is the time of the year in which most of the small fresh-water crustaceans spawn and produce living young, and food is, therefore, much more abundant at this season than at any other.

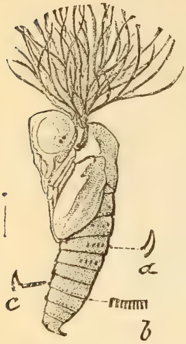

FIG. 12.—*Simulium pecuarum* pupa—enlarged (from Riley).

When fully grown the larvæ descend to near the bottom of the stream, sometimes 8 or 10 feet, to make their cocoons.

The cocoon upon these leaves is conical, grayish or brownish, semitransparent, and has its upper half cut square off, more or less ragged, as if left unfinished. Its shape is irregular, the threads composing it very coarse, and the meshes rather open and ordinarily filled with mud. They are not always fastened separately, but frequently crowded together, not forming, however, such coral-like aggregations as in some of the Northern species. The larva in spinning does not leave its foothold, but running in the center of its work uses its mouth to spin this snug little house. In it, it changes to a pupa, which has its anterior end protruding above the rim.

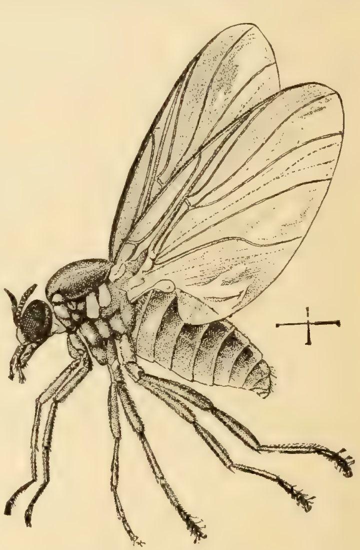

FIG. 13.—*Simulium pecuarum:* female, side view—enlarged (from Annual Report Department of Agriculture, 1886).

The pupa (fig. 12) is, when fresh, of a honey-yellow color, the filaments of the front part of the body brown and the abdomen above tinged with brown. The filaments consist of six main rays issuing from the basal prominence and subdivided two or three times, so that in most cases as many as forty-eight terminal filaments can be counted. The color of the pupa changes with age, becoming pinkish, and, just before emergence of the fly, black. "During the first of these colorational epochs they are attached to the vegetable substance upon which the pouch has been fastened by the thoracic filaments, by threads about the body, and by the anal extremity; but during the last two the pupæ hang by the short anal attachment alone to the threads at the bottom of the pouch and rise more and more out of it, until they swing freely in the current, attached only by the drawn-out threads."

They remain in the pupa state but a short time. Both larval and pupal skins remain in the pouch for some time.

The adult fly on emergence from the pupa rises quickly to the surface, runs a few inches over the water, and the wings expanding almost instantly it darts away. The fly (fig. 13 side view, fig. 14 dorsal view of female) is nearly a quarter of an inch in length, the female being somewhat larger than the male and differing in many respects. The color is black, but the body is covered with grayish brown, short, and silken hairs, which are arranged upon the thorax in such a manner as to show three parallel longitudinal black stripes. The abdomen is more densely covered with similar hairs and shows, furthermore, a broad dorsal whitish stripe, which widens toward the posterior end.

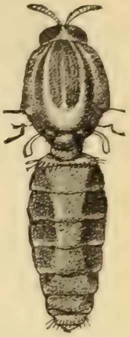

FIG. 14. — *Simulium pecuarum:* female, from above — enlarged (from Annual Report Department of Agriculture, 1886).

The male differs in the structure of the head (fig. 15; head of male at the right; of female at the left), the eyes being larger, joining each other in the middle line, and the individual facets being much larger on the upper part of the eye, while those of the lower part (not correctly shown in the figure) are minute, the line of separation between the two sizes being well marked.

The time of appearance of the swarms is regulated by the earliness or lateness of the spring, and consequently it is much earlier in the southern parts of the Mississippi Valley. As a rule, they can be expected soon after the first continuous warm weather in early spring. In 1885 the first swarms were observed in Louisiana March 11, in Mississippi and Tennessee May 1, and in Indiana and Illinois May 12.

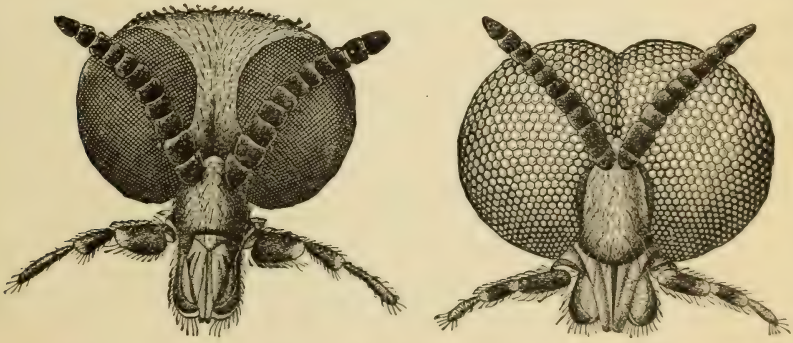

FIG. 15.—*Simulium pecuarum:* head of male, at right; head of female, at left—greatly enlarged (from Annual Report Department of Agriculture, 1886).

The accounts of its occurrence in December or other winter months do not seem to agree with the observations of recent years, but are perhaps explicable on the ground of unusual seasons at the time of such appearance. Small or local swarms may appear somewhat earlier or later in the neighborhood of their breeding places. The number of individuals in a swarm can not be computed, as it varies greatly. The swarms lead a roving life, being drifted about by the wind and are frequently carried long distances from their usual haunts.

At first the members composing a swarm are very active and bloodthirsty; but they soon die, and the swarm decreases gradually and soon disappears entirely. New swarms appear continually and replace the former ones. The duration of an invasion throughout the regions infested varies from a few days to five or six weeks. If cold weather follow their appearance, the gnats become semi-dormant; they are not killed by it nor by rain, but revive and become aggressive again with the first warm rays of the sun. Hot weather, however, soon kills them and puts an end to any further injury. The duration of life of a single individual is short; at least specimens confined even in large and well-lit boxes soon die. Buffalo-gnats that have once imbibed blood of any animal also soon die, as seen by the large numbers found dried up in stables in which they have been carried attached to mules or horses. In the fields gnats filled to repletion with blood drop to the ground and crawl away, soon to die. They suffer, therefore, from their bloodthirsty habits, and this seems to be quite a general rule with all those blood-sucking species which are known to annoy man and other warm-blooded animals; for the love of blood generally proves ruinous to those individuals which are anxious to indulge in it, as we have shown to be the case with the harvest mite or jigger.[1]

CHARACTER OF A SWARM.

The number of individuals comprising a swarm can not be computed, as swarms vary greatly in size. Their presence is at once indicated by the actions of the various animals in the field. Horses and mules snort, switch their tails, stamp the ground, and show great restlessness and symptoms of fear. If not harnessed to plow and wagon they will try to escape by running away. Cattle rush wildly about in search of relief. Formerly, when deer were still numerous, they would be so tormented by these insects as to leave their hiding places and run away, seeking protection even in the presence of their greatest enemy, man. Approaching animals in the field, we notice at once small black bodies, exceedingly swift in their flight, darting about their victims in search of a suitable spot to draw blood. But even during a very general invasion by these gnats these insects are not uniformly distributed throughout the region infested, but they select certain places. Only low and moist ground is frequented by them; exposed or sunny spots are never visited. There may be no indications of gnats in a whole neighborhood, and the unprepared farmer, dreaming of no danger to his mules or horses in passing dense thickets of bushes, etc., near the roadside, is suddenly attacked by a swarm of these pests, and is frequently unable to reach a place of safety in time to save his cattle. As suddenly as such swarms appear, just as suddenly do they disappear. During a gnat season cautious farmers never travel with their horses or mules without providing themselves with some kind of protective grease.

When buffalo-gnats are very numerous the whole air in the vicinity of our domestic animals is filled with them at times, and looking toward the suffering brute, one sees it surrounded by a kind of haze formed by these flying insects. Sweeping rapidly with the hand through the air one can collect hundreds of gnats by a single stroke. They crawl into everything, and the plowman has constantly to brush them away from his face, which does not always prevent them from entering and filling his mouth, nose, and ears; he is so tormented by them, and frequently by their bite as well, that he has to cease working for the time being. Thousands try to enter the houses in villages and cities, and the windows are frequently completely covered with them.

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[1] See American Naturalist, Vol. VII, 1873, p. 19.

MODE OF ATTACK.

The flight of all species of *Simulium* is very swift and powerful. They possess, in comparison with most other flies, an enormously large thorax, consisting of a very tough, chitinous integument, that furnishes ample attachment for the strong muscles which propel them during their long and continuous flights.

The Southern buffalo-gnat is exceedingly active in all its motions, and is at its bloody work as soon as it has gained a foothold upon an animal. The individual flight is inconspicuous and rarely more than a few feet from the ground. It is also usually noiseless, but when one passes rapidly close to the ear of a person the sound produced is faintly like that of a passing bullet, and no one who has listened to it will ever forget it, but will always connect it with their presence.

If the insects are not very hungry, or if influenced by too warm or too dry an atmosphere, they circle round a mule or a horse very much like so many small bees; if hungry, however, they lose no time whatever, but with a few nervous jerks settle upon the selected spots and immediately go to work. They are never quiet, but are most active during early morning and toward evening. They also fly during moonlight nights. During the hottest portions of the day, from 11 a. m. to 4 p. m., they are more or less inactive. Their favorite time of attack is a cloudy, dark day, or when rain is threatening. If the gnats try to enter houses or stables by means of the windows, they constantly butt their heads against the panes of glass, until they become so exhausted that they drop to the ground and die. Specimens kept in confinement in large vessels, with the bottoms covered with moss and soil and containing a wet sponge and a saucer filled with water, die within forty hours. During all this time they never cease trying to escape. The sense of smell (and sight) of these insects must be well developed, because they unerringly find animals a long distance away from their breeding places. If very numerous they cover the whole animal, without making any selection of position.

The smaller turkey-gnats are not so bloodthirsty, nor do they form such large swarms. The snorting, biting, switching of tails, and the general restlessness of the stock in the fields soon reveal the presence of their foes. The gnats will, upon arrival, rapidly circle around the animal, select a point of attack, fasten themselves upon the chosen spot, and immediately commence to bite. The genital and anal regions, the ears and portions of body between the forelegs—in short, those parts where the skin is most easily punctured—are selected by these insects. The attack is so rapid that in course of one minute the body of the tormentor is seen to expand with blood, which shows plainly through the epidermis of the abdomen. The bitten part of the animal shows a nipple-like projection, and if the insect is removed by force a drop of blood as large as a good-sized pin's head will ooze out. Other gnats will almost at once pounce upon the same spot and continue the biting. All those veins which project under the skin of the animal are also favorable points of attack, and their course is made visible by the hordes of gnats fastened upon them.

REMEDIES TRIED AND PROPOSED AGAINST THE LARVÆ.

The results of a number of different experiments with insecticides upon the larvæ of the buffalo-gnats made by Mr. Lugger during the early spring indicate that it is nearly if not quite impossible to reduce their numbers by killing them in the streams. To attempt to do so when all these streams are swollen, and frequently from 10 to 20 yards wide and half as deep, would be sheer waste of time. When the water is very low and much more sluggish in its motion, thus bringing the chemicals in contact with the larvæ, an application of them might be more effective. Great caution must be used in any efforts in this direction, however, as both man and beast are in many localities entirely dependent upon these streams for their water supply, and the introduction of poisonous substances might cause much trouble.

Some of the experiments were made by confining the larvæ in glass tubes and submitting them to a current of water to which the following decoctions and solutions had been added, viz: China berries, salt, lime, sulphur, tar water, kerosene emulsion, and carbon-bisulphide. Strong tar water killed them; diluted, it proved harmless. Kerosene emulsion diluted to contain 5 per cent kerosene was effective; 3 ounces of carbon-bisulphide in 7 quarts of water proved fatal within ten minutes; the other insecticides were ineffective. It would be very costly to put enough of these materials in the water to produce the desired effect.

If the general opinion that broken levees are to blame for the destructive swarms of buffalo-gnats prove to be the correct one, the restoration of such levees would, within a few years at most, restore the former immunity from these insects. This time would be materially hastened by the removal of obstructions in all such parts of the bayous where they would come in contact with the swiftest current.

OVERFLOWS AND BUFFALO GNATS.

It is very generally claimed by the inhabitants of the infested region that as long as the States bordering upon the Mississippi River had a perfect levee system, which prevented the water from escaping into the inland bayous, no damage was occasioned by buffalo-gnats, not even in districts now badly infested. It is further claimed that the buffalo-gnats appear with every overflow, and only with an overflow if such overflow occur at the proper season and with the proper temperature, viz., during the first continuous warm days of March, April, or May.

The chronological data already given seem to prove such assertions correct. Too much weight should not, however, be attached to these data. The region is as yet rather thinly settled, and no systematic records of the appearance of buffalo-gnats in injurious numbers have ever been kept. A general and widespread appearance of these insects seems to take place, however, only during an inundation, and, granting the connection between the two phenomena, the causes for it are yet obscure. It was by the elucidation of this problem that we hoped to discover some means of preventing the injury of the flies by preventing the multiplication of the larvæ.

Inundations in the lower Mississippi Valley are not occasioned by local rains, but by the immense volume of water brought down by the river and its more northern tributaries, and such overflows first take place in the northern regions infested by the buffalo-gnats, and not in the southern. The earlier appearance of these insects in the South would seem to invalidate the prevailing belief that an overflow brings them. Similar conditions prevail in Hungary, where a closely allied insect does so much injury to all kinds of live stock. There the gnats appear every spring in varying numbers, forming local swarms which move about with the wind; but no general invasion takes place until the River Danube inundates the region infested.

Is it not probable that swarms of these gnats are forced by the conditions consequent upon an inundation to extend their flight beyond their usual haunts to the more elevated and drier regions, and that in this fact we have at least one of the causes of the connection? Small swarms, otherwise local and unobserved, would thus, during a period of high water, be forced to band together in such immense armies. There must be other reasons, not yet clearly demonstrated, why these insects appear in such vast swarms with an overflow, and this problem can only be solved by a critical study of many breeding places during several seasons over the whole region involved.

Some peculiarities of the swarms of buffalo-gnats have been observed, and these may, by closer study in future, throw some light upon the problem. It is to be noted that all the specimens composing these swarms are females, and that not one male has been found among them either here or in Europe. There is every reason to believe that none of the females composing the blood-thirsty swarms return to the localities where they were born and developed. Experience indicates that once gorged with blood they die. The swarms dwindle in proportion as they are carried away or move from their breeding places.

Close investigation with the microscope has failed to reveal any eggs in the ovaries of the females composing these swarms, and if they deposit eggs at all it is before congregating to attack animals.

These singular facts invite speculation and theory, but it were unwise to indulge in these before we have learned more about the eggs, when and where deposited, and whether the females depositing them are in any way different from those comprising the swarms. Dr. Fritz Müller has published in the Archivos do Museu Nacional do Rio de Janeiro, Vol. IV, page 47, Pls. IV–VII,[1] some very interesting observations on another fly (*Paltostoma torrentium*), the larva of which is only found in the torrents and cascades of certain streams descending the mountains of Brazil. There the pupæ fasten by the flat venter to the rocks under water, and change into the perfect flies. He found by opening the mature pupæ that there are always two forms of females associated with one form of male. The one form of female possesses a rudimentary mouth, only fit to sip honey, while the other has a mouth well adapted to penetrate the skin of warm-blooded animals and to suck blood.

The male Simulium, so far as known, is only found near where it developed. The structure of its mouth prevents it from biting, and it shows no inclination to join the roving swarms of females. Hence pairing of the sexes must take place in the vicinity of birth, and the eggs are probably deposited soon afterwards. It is also possible, as in the case of other Diptera, that the eggs are already well developed in the pupa.

The condition of the inundated region forbids an indiscriminate selection of places to deposit in, since the young larvæ must in time find suitable swift currents of water after the subsidence to the normal level. Such breeding places we hope to be able to map out in future.

It has also been claimed that a number of successive broods of the buffalo-gnat appear in early spring. If such were the case the relationship between the presence of the gnats and an overflow could be very readily imagined; but we have already shown that there is absolutely no proof thus far of more than one annual brood.

Mr. Webster, while studying in the neighborhood of Vicksburg last spring, was impressed with the idea that the connection between the Simulium increase and overflows was dependent upon the condition of the levees, in that the river water in swelling the waters of the bayous not only creates a stronger current in the main bayou, but brings the current in contact with many trees and shrubs, as well as stumps and vines, along the bayous, thereby offering much greater chance for the larvæ to attach themselves.

While we were at first inclined to give some weight to this view, and it seemed to afford an additional important argument in favor of keeping the levees in good condition, a survey of the whole field leads us to abandon this as the most important cause in the increase of the gnats during the period of the overflow, and to adopt the theory already advanced, viz., that the connection is at least partly due to the gnats being driven by the advancing waters from the lower to the higher lands.

Another theory, not supplanting this last, but supplementing it, we would advance here: There is no doubt but that the advance of the waters from the main river and their commingling with the clearer streams and tributaries carry a suddenly increased food supply, in the way of minute crustacea and other aquatic creatures, to the Simulium larvæ just at the season when these are about to transform. It is quite probable that development in these larvæ remains more or less latent or stationary during the cold winter months or when the water in which they occur is depleted of minute animal life, and that a sudden access of food would accelerate the final transformations.

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[1] Reviews of his paper appeared in Kosmos, Vol. VIII, pp. 37–42; Nature, July 7, 1881, p. 214; Entomologist's Monthly Magazine, February, 1881, p. 206 and pp. 130–132, and March, 1881, pp. 225, 226.

A possible third connection between the overflow and this increase may arise from the fact that the larvæ, when the water rises, leave their attachments, or that the débris upon which they are fastened becomes itself started by the flood current, and that in consequence the larvæ from hundreds of smaller streams and tributaries are carried away by the rising water and impelled into the current of the large streams, by which they may be carried for many miles, spreading out at last in the overflowed region at just the time when they are ready for their final transformations. On this theory the larvæ from regions far distant become massed in the overflowed region and vastly augment the numbers which have naturally bred there.

THE TURKEY GNAT.

(*Simulium meridionale* Riley.)

The early history of the turkey-gnat is so intimately connected with that of the preceding species, and the losses due to the two species have been so generally confused, that what has been already stated upon these topics covers about all that can be said. It is unnecessary, therefore, even if it were possible, to give separate account in detail.

In the insect itself, however, and in many details of its life history and habits, there is so much difference that it becomes necessary to give some attention to them.

LIFE HISTORY.

While the area occupied by the adults corresponds in general with that of the *S. pecuarum*, the breeding places appear to be quite different. In this species the breeding grounds are limited to the smaller streams and branches, and the larvæ are found attached to submerged dead leaves. Often these leaves are held by sticks, rails, and other obstructions, which serve to fasten them in the mud and at the same time create currents which are favorable to the existence of the larvæ.

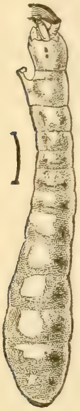

FIG. 16.—*Simulium meridionale*: larva, side view—enlarged (from Ann. Rept. Dept. Agr. 1886).

The larva has the peculiar shape and appearance of the Simuliidæ larvæ in general (see fig. 16 for the larva, the hair line giving natural length). The markings of the head and body are much more irregular than in *S. pecuarum*. They usually possess one or two lateral spots on the enlarged hind part of the body; the head lacks the regular arrangement of spots and lines; the breathing organs are quite different, and three main trunks branch each six times and the branches enter the trunk from the sides.

These larvæ are evidently somewhat social in their habits, as they crowd together upon one leaf in numbers varying from ten to thirty, and, judging from their uniform size, they must be the offspring of the same parent. As the current away from obstructions caused by twigs and leaves decreases in swiftness, so do the larvæ decrease in numbers, until only a few feet away but one or two can be found.

When first found, in early March, they are quite small, but they grow rapidly during the latter part of March and early April. They are quite stationary when not disturbed. Besides being fastened to the leaf by the last posterior segment, they are also securely anchored by a very fine silken thread. When disturbed they loosen their hold at once and float down stream, suspended and retarded by this thread, which very rapidly increases in length while the larvæ are drifting with the current. While thus drifting they jerk about in a lively manner, searching for a new resting place, and sink to the bottom quite gradually. Owing to their small size and to the fact already stated, that their color is in harmony with their surroundings, or with the leaf upon which they are fastened, these larvæ are difficult to detect in a depth of 3 to 4 inches. When removed and put in a glass vessel they soon settle against the sides of their prison and can then be studied with a lens.

The larva can move about very rapidly in the manner of a span-worm, but with this difference, that it always remains anchored by means of a thread, which lengthens as the animal proceeds. Being very restless and active in such confinement, it will keep on looping for hours, at a rate of twenty to twenty-five loops per minute. It can move both forward and backward, the forward motion being produced by fastening the single thoracic leg to the side or bottom of the vessel, loosening the anal proleg, bringing it close to the former, and letting the latter go at almost the same moment, the backward motion being simply a reversal. In the course of six to eight hours the larva becomes weak and sickly. It will drop to the bottom of the vessel if disturbed, but will no longer try to escape. All the larvæ thus imprisoned, in repeated trials, died in the course of twenty-four hours. A colony of nearly full-grown larvæ, in a small creek, shared the same fate when the overflow of the Mississippi River created a back flow and made the water in this creek stationary for some time.

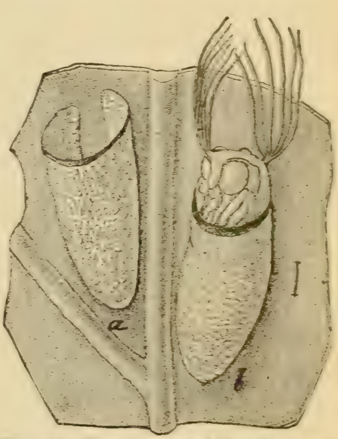

FIG. 17.—*Simulium meridionale*: *a*, cocoon; *b*, pupa—enlarged (from Riley).

All the creeks and branches in which such larvæ were found by Mr. Lugger descend in beds composed of clay. The Rocky Bottom Branch, a tributary to the Horn Lake Creek, Mississippi, has worn out a bed in a solid deposit of stratified ferruginous sandstone, intermixed with conglomerations of the same substance. The water, 6 to 8 inches deep in normal seasons, even during the summer months, runs over this stony bed in very rapid currents, forming everywhere little cascades, and no better breeding places for the larvæ of any Simulium could be imagined. Yet none could be found, plainly indicating that the species under consideration must be able to fasten to submerged material to find a suitable home.

The larvæ form their cocoons just above the bottom of the smaller perennial streams and are hence not endangered by the variations in the depth of the water, for while it may rise suddenly with every heavy rain and fall as suddenly afterwards the depth is quite uniform at other times.

The cocoon (fig. 17, *a*) is much neater than that of *S. pecuarum*, being formed of fine threads, lined with gelatinous ones. The web is quite dense, uniform, with well-defined, sometimes thickened rims. The cocoon is always securely fastened singly to a leaf or stick, and even if many are fastened upon the same leaf they do not crowd each other.

It fits snugly about the pupa, which is so securely anchored inside as to be with difficulty extricated.

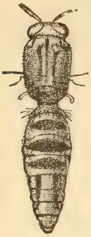

FIG. 18.—*Simulium meridionale:* female—enlarged (from Ann. Rept. Dept. Agr., 1886).

The pupa (fig. 17, *b*) has the general shape and coloration of that of *S. pecuarum*, but the thoracic filaments consist only of the original six rays, which do not branch. The length of the pupa stage for this species averages five days.

The adult insect (fig. 18, female; fig. 19, male) has the general apearance of *pecuarum*, but is smaller and lighter in color.

The females are 2.5 to 3 mm. in length, the males from 1.5 to 2 mm. The females are of a general slate-blue color and have darker markings on the thorax and abdomen, as shown in the figure. There is also a silvery pubescence over most portions of the body, and the colors of some parts change in certain lights, giving greenish, coppery, and dark blue. The male has confluent eyes composed of two very different sets of facets, which are clearly shown in the figure. The body throughout is darker, mostly black with bluish luster, and rather sparse white pubescence.

The flight, method of attack, and other habits of this species need not be given separate description, neither is there anything to add regarding remedies that may be available for the destruction of the adults or prevention of their injuries.

The breeding places of the larvæ, however, seem more open to attack than the others, and experiments recorded in the report of the Department for 1886 show that it is possible to affect them with solutions added to the water, but not with great success, except when used in such quantities as to kill other insects, fishes, etc., which probably prey upon the gnat larvæ.

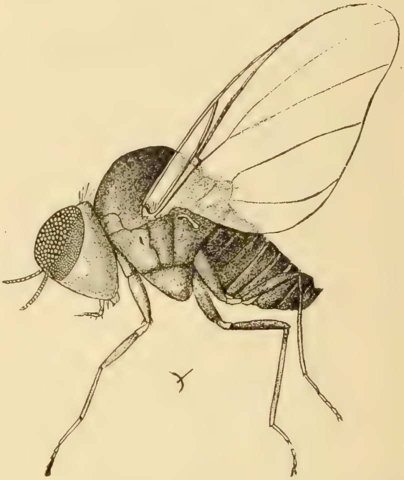

FIG. 19.—*Simulium meridionale:* male—enlarged (from Ann. Rept. Dept. Agr., 1886).

If the breeding places in the creeks have to be searched out to apply the insecticides, it would be much more simple to remove all the logs, sticks, and leaves. All the fences across the branches should be removed, or rather replaced by wire fences, which would neither impede the current nor catch as many sticks and leaves. Logs and larger twigs, if not embedded too deep in the mud of the creek or banks, will always be removed by the high water, a very common occurrence in the buffalo-gnat region. Old leaves made heavy by the adhering mud would also be carried away by any high water if the obstructions in these creeks were removed, and with the sticks and leaves many, if not most of the larvæ, would be carried away either into the main rivers or the lower level of the creeks or lakes where there is no current and where they would perish.

THE WESTERN BUFFALO GNAT.

(*Simulium occidentale* Townsend.)

This buffalo-gnat is first recorded by Mr. C. H. T. Townsend, in 1891 (Psyche, Vol. VI, p. 106), from southern New Mexico.

While no subsequent records have appeared, there is little doubt that it has continued to appear along the river valley where it was first observed. I can do no better than to quote from Mr. Townsend with regard to its habits, etc.:

> In the southern part of New Mexico, along the valley of the Rio Grande, there begins to appear about the 1st of May a buffalo-gnat which is quite as troublesome, especially to man, as its more Eastern congener, *S. pecuarum*. It proves to be an undescribed species. The first individuals that I have noticed this year were in an orchard near Mesilla, on the 7th of May, and they were at that date swarming in considerable numbers. Mesilla is about a mile from the Rio Grande, which flows to the west of the town. Gnats were found also on the same date, but in less numbers, on the college grounds, which are situated about 4 miles from the river. The river rises in May, overflows all the low areas lying adjacent to it, and becomes a roaring, rushing body of water. Its volume is dependent upon the amount of snow in the foothills to the north, particularly in Colorado, and on the rains, which are only exceptionally a factor. The snow in the canyons exerts little influence, for its thaw is so gradual as not to be felt. I give these data for what bearing they may have on the breeding habits of this species. It is well known that Simulium breeds in running water, and our species is no doubt dependent on the rise of the Rio Grande for its appearance. Doubtless, also, it is distributed through the valley by the system of acequias or irrigation ditches in use in this country, which open from the river on a higher level to the north, and furnish the only source of water supply for the raising of crops. This is an adverse bearing of the riparian irrigation on injurious insects. The securing of artesian water and shutting off of the river water would no doubt lessen the dispersion of the gnats through the valley.
>
> From the first part of May the gnats increase in numbers, until by the middle or last of the month they are very abundant in all parts of the valley. It is usually between this time and the middle of June that the river is at its highest point. They are then to be found on the mesa to the east toward the Organ Mountains, and may be met with also on the elevated mesa nearer the mountains, especially to the north. On May 17 I observed them on the summit of the first mountain at the eastern end of the Doña Ana range, which is nearer the river than the Organs, and farther north. The elevation is at least 4,500 (probably 5,000) feet above sea level, or about 1,500 (perhaps 2,000) feet above the level of the river. They are not found in the Organ Mountains, which are about 20 miles east of the river, nor on the plains to the east and south of them, though on the mesa to the west they approach to within a few miles. This was observed May 23–24, while in the valley itself at this time they were almost unbearable.
>
> These gnats are a great annoyance to man, by far greater than any other insect that we have in this locality. Many persons are so susceptible to them as to preserve through the height of the gnat season a chronic inflammation of the exposed

parts of the face and neck, resulting from the repeated bites, which cause an intense irritation and even give rise to cutaneous sores. The inclination of the gnats to bite increases with the advance of the season, but the pest is considerably abated after the fall of the water. They are also very troublesome to animals, and are supposed to cause the inflamed eyes in the horses of this region through the summer months. I append a description of the species. The female is alone described, as that is the only sex which composes the biting swarms, and I have not secured either the male or the early stages.

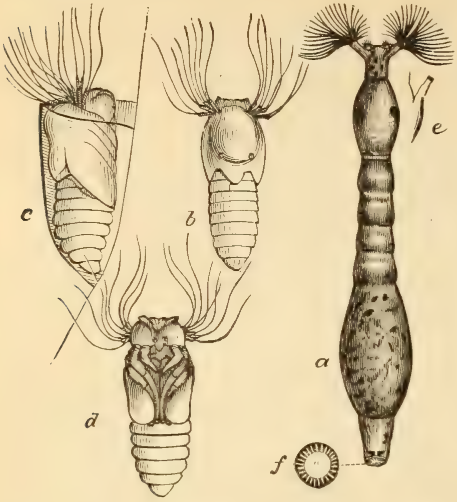

FIG. 20.—*Simulium piscicidium:* *a*, larva; *b*, pupa, dorsal view; *c*, same, lateral view; *d*, same, ventral view; *e*, thoracic proleg; *f*, rows of bristles at end of body (from American Entomologist).

Compared with other forms, Townsend says:

> This species is smaller than either *S. pecuarum* or *S. meridionale*. *S. metallicum* Bell, from Mexico, is given as 2 mm. long, but it is the male which is described, and the female would be very much larger. *S. occidentale* differs from *S. pecuarum* very markedly in the thoracic and abdominal markings. These markings are very much like those of *S. meridionale;* but the median thoracic line is always very faint, the abdomen is light fulvous, the lateral lines of segments 5, 6, and 7 are curved, and the abdominal markings are of a different color, besides other minor differences.

Simulium piscicidium Riley.

The past history of this species, together with the important features of its life history, have already been stated in connection with the discussion of the habits of the members of the family.

It has been recorded from New York and Ohio, but further than this we are not informed as to its geographical limits.

The eggs of this species have not been described, nor is it known where they are laid, or the details of the early life of the larva. The larger larvæ and their habits, to some extent, have been detailed and already referred to The accompanying figures will serve to show the similarity to the other species, and we include them in order to bring together as much as possible the material which will be of service in the further study of the habits of the group.

The adult described in the American Entomologist (Vol. II, p. 367) is for the most part velvety black, with a faint fulvous pubescence on the thorax, and the eyes and sides of the abdomen inclining to brownish or rufous. The length of the body in alcoholic specimens is 0.14 to 0.17 of an inch.

So far as known the adults never exhibit the bloodthirsty propensities of their Southern cousins.

Simulium canescens Bremi.

This species has been studied by Kolliker, according to a citation of Osten Sacken (American Entomologist, Vol. II, p. 231).

Simulium rivulare Planch.

Cited by Osten Sacken (American Entomologist, Vol. II, p. 231). It does not appear that it is discussed from an economic standpoint.

Simulium sp.

A species of Simulium is said to be a serious pest in Brazil. It was first technically discussed by Pohl and Kollar.

Simulium venustum Say.

In 1823 Thomas Say described in a paper entitled "Descriptions of dipterous insects of the United States" a number of Diptera which he says were collected chiefly during the expedition to the Rocky Mountains under the command of Major Long. Among the rest is the description of the present species and the following note: "This very pretty species perched in considerable numbers on our boat at Shippingsport, Falls of the Ohio. It ran with considerable rapidity, constantly advancing its long anterior feet. Its bite is pungent."

While very probably one of the forms included under the general head of buffalo-gnats of the Mississippi Valley no further records of its especial attacks are known, and nothing is known as to the larval form from which it develops. Shippingsport does not appear on present maps, but the "Falls of the Ohio" lie between Louisville, Ky., and Jeffersonville, Ind., and since some of these species are peculiarly local in their distribution, it would be courting success to search for the larvæ in the rapids of the river at that point.

Say's description of the adult form is as follows:

> Black; thorax, two perlaceous spots before and a larger one behind; poisers black, capitulum bright yellow, dilated.
>
> Inhabits Shippingsport.
>
> Body black; wings whitish, with yellow and iridescent reflections.
>
> Male, eyes very large, separated only by a simple line, dull reddish yellow, inferior half black; thorax velvet-black, a bright oblique, perlaceous, dilated line each side before, and a large perlaceous spot or band behind; sides beneath varied with perlaceous; feet, tibia above, and first joint of the four posterior tarsi white; abdomen with an oblique perlaceous line at base, and two approximate, lateral, perlaceous ones near the tip.
>
> Female, eyes moderate; thorax plumbeous-black, immaculate; scutel black; abdomen whitish beneath.

Simulium sp.

Baron Osten Sacken, in his careful paper in the American Entomologist on the habits and structure of species of Simulium, describes a larval form common in streams near Washington, but does not connect it with any species described in the adult form. His figures, which represent only certain parts of the anatomy, are here reproduced (fig. 21).

Possibly the observations made by Dr. Howard may refer to the same species. In this case the larvæ are found attached to the rocks forming the bed of the stream, and their habits generally conform with those of the Northern species.

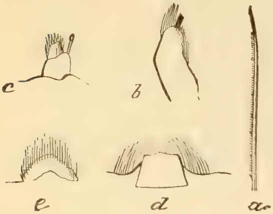

FIG. 21.—*Simulium* sp.: *a*, portion of ray of fan; *b*, mandible; *c*, maxilla; *d*, under lip; *e*, upper lip—all enlarged (after Osten Sacken).

Simulium pictipes Hagen.

This species has already been mentioned as described by Hagen (Proc. Bost. Soc. Nat. Hist., Jan., 1880).

Larvæ and pupæ occurred in the Au Sable River, Adirondack Mountains.

Family TABANIDÆ.

(Horse Flies, Gad Flies, etc.)

The members of this family are large, some of them being among the largest of the order Diptera, and the females are provided with powerful mouth parts by means of which they inflict very painful bites upon cattle, horses, and other animals. Man does not escape, and as they are able to penetrate even thin clothing worn in summer, they sometimes become a source of annoyance to workmen in fields.

The bodies are never very hairy, the head is large and composed almost entirely of the eyes, which during life are of brilliant colors and varied reflections. The antennæ are prominent and the third joint is composed of from three to eight minute rings, a character which, with the large eyes, distinguishes them at once from nearly all other large flies. The strong piercing mouth parts of the female are composed of six lancet-like organs, while in the male there are but four and these are not adapted to piercing the skin of animals. The males, and also the females, if not finding other food, feed upon the nectar of blossoms or the juices of plants, exuding sap from trees, etc.

The flight of these flies is very strong and rapid and is attended with a buzzing, tormenting noise. The males may often be seen with the wings vibrating so rapidly that they become invisible, resting motionless in one place and then darting rapidly and resting suddenly again, generally turning the head in some other direction each time they dart.

St. Fargeau has ascertained that this maneuvering is performed in order to intercept and seize the females. The power of vision is apparently in proportion to the size of the eyes. Dr. Williston says, "that they can see for a long distance seems certain. On the uninhabited plains east of the Rocky Mountains the writer has frequently seen them coming from a long distance, attracted by the sight of the horse on which he rode."

Such of the larvæ as are known are either aquatic or live in moist earth and are canivorous, hence they may in some degree compensate for the bloodthirsty habits of the adult females. But notwithstanding the abundance of the insects, very little has been done toward determining the early stages of the species. More than a century ago De Geer described the larva of the common European species, *Tabanus bovinus*, and up to 1864 this was the only larva of the kind known. In that year Mr. Walsh described a tabanid larva (Proc. Bost. Soc. Nat. Hist., Vol. IX, pp. 302–306), but without obtaining the adult form. In 1869 Professor Riley bred the same kind of larva to the adult form and described the various stages (Second Rep. Mo. State Entom., pp. 128–132), the insect proving to be *Tabanus atratus* Fab., which is described further on.

Dr. Williston says: "The spindle-shaped brown or black eggs are found in spherical or flat groups, stuck together, and attached to the leaves or stems of grass and other plants; those of the aquatic larvæ are fastened to rushes. The larvæ are carnivorous; many live in the earth, others in water. They are predaceous, often upon snails and injurious insects, thus in a measure repaying the agriculturist for the molestation they cause him. The young larvæ are known to penetrate beetles or other larvæ and remain within them till they have completely consumed them, and their enlarged bodies have filled out the skins. Thus the larvæ of Hæmatopota have been observed feeding upon Helops and those of Tabanus upon Noctuæ." (Stand. Nat. Hist., Vol. II, p. 417.)

Quite recently Mr. C. A. Hart has made a notable contribution to our knowledge of this subject,[1] which will be drawn from in discussing the early stages of particular species.

Authors generally agree that the after effects of the bites of these insects are less injurious than those of mosquitoes or buffalo-gnats. The painfulness of the bite and the terror inspired by their presence is, however, a source of great torment to animals that are almost helpless in protecting themselves against them. The puncture they make is large, and after the proboscis is withdrawn there is not unfrequently an exudation of blood from the wound. This would tend to remove any poisonous injection, but since there is rarely any swelling or inflammation produced by these bites, it would appear that no poison is conveyed upon their piercing organs. Dr. Packard speaks of cattle and horses being "occasionally killed by their repeated harassing bites," and while this seems to be rather strong language, and we will refer to it again in considering *Tabanus lineola*, there is no question that the effects are serious enough, so that it is desirable to protect animals as far as possible from their bites.

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[1] Article VI, Vol. IV, Bull. Ill. State Lab Nat. Hist.

With horses in use the common practice of protecting with nets is the most effective method we know of, but for animals in pasture it would be particularly desirable to find some substance which could be rubbed over the hair, and, retaining its properties for a reasonable length of time, have sufficient repelling power to keep the flies away.

The larvæ are not open to successful attack, and even if they were, the fact that most of them are probably beneficial should deter us from using destructive measures against them.

They are widely distributed, and species occur in all parts of the world, torturing alike the elephant and lion of the tropics and the peaceful reindeer of the arctic region. It is during the hottest summer months that they are the most abundant, and they frequent both our timbered and prairie regions.

The species are quite numerous, over 1,300 being known, of which about 150 are credited to North America. Manifestly it would be impossible in a work like this to even mention more than a few species, and, since so little is known of the early stages, there is no necessity for treating each species in detail. We will therefore in considering the species simply refer to the more common ones, the habits of which have been observed, and more particularly those occurring in this country.

Osten Sacken's admirable "Prodrome of a Monograph of the Tabanidæ of the United States" in Memoirs of the Boston Society of Natural History (Vol. II, Part IV, Nos. 1 and 4) will enable anyone to make a thorough study of our native species.

THE BLACK GAD FLY OR BREEZE FLY.

(*Tabanus atratus* Fab.)

Probably this is the largest species in the family, and it is certainly one of the most conspicuous, being quite common and of such a decided black color as to attract attention either on the wing or when perched on the back of some poor animal that tries in vain to drive it off. Fabricius described it in 1794 (Ent. Syst., Vol. IV, p. 366). Walsh described its larva in 1864 (Proc. Bost. Soc. Nat. Hist., Vol. IX, pp. 302–306), and in Riley's Second Missouri Report (p. 128) its life history is given except the egg and early larval stages. Its bite is one of the most severe of the tribe, but fortunately the species does not occur in such great numbers as the green-head fly. Its attacks seem more commonly directed against cattle than horses, and it is most noticeable in sunny pastures, though occasionally seen perched on trees or the side of some building. The eggs are doubtless deposited in the vicinity of water, in moist places, but the exact details of oviposition are unknown.

The larva (fig. 22, *a*) is a large, twelve-jointed, cylindrical affair, tapering at each end, of a transparent, highly polished, glassy, yellowish, or greenish appearance, shaded with bluish green and furnished above and below, as in the figure, with large, roundish, sponge-like tubercles which are retracted or exserted at the will of the insect. Though the external integument is so transparent that the internal structure is readily visible, yet this integument is firm and the larva most vigorous and active, burrowing with great strength either backward or forward in the earth and between one's fingers when it is being held. Placed in water it will swim vigorously by suddenly curling round and lashing out its tail, but it is apparently not as much at home in this element as in the moist earth, for it is restless and remains near the surface with the tip of its tail elevated in the air. When the water is foul, it moves about actively near the surface, but when it is fresh it remains more quiet at the bottom. The specimen which I succeeded in breeding was sent to me by Mr. Adolph Engelmann, of Shiloh, St. Clair County, Ill. It was found by Mr. William Cooper, of the same county, about 10 feet from a small but permanent body of water. Mr. Cooper at first took it to be a leech, and when he attempted to capture it it immediately commenced burrowing in the ground.

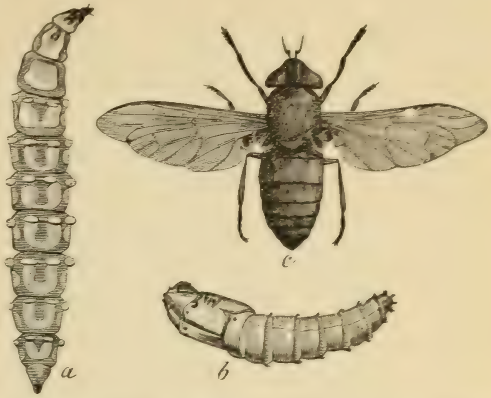


FIG. 22.—*Tabanus atratus*: *a*, larva; *b*, pupa; *c*, adult (after Riley).

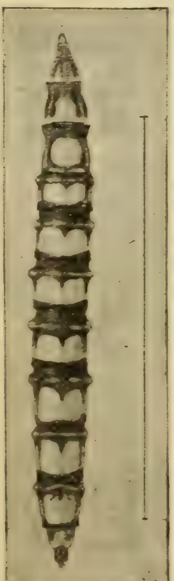


FIG. 23.—*Tabanus atratus*: larva (from Hart).

The larva reared by DeGeer was terrestrial. This larva is semiaquatic, for it is quite at home either in moist earth or water. My specimen was kept for over two weeks in a large earthen jar of moist earth well supplied with earthworms.

It manifested no desire to come to the surface, but burrowed in every direction below. I found several pale, dead worms in this jar, though I can not say positively whether they had been killed and sucked by this larva. Mr. Walsh, in speaking of its haunts and its food, says:

> I have, on many different occasions, found this larva among floating rejectamenta. On one occasion I found six or seven specimens in the interior of a floating log, so soft and rotten that it could be cut like cheese. Once I discovered a single specimen under a flat, submerged stone, in a little running brook. Finally, I once met with one alive, under a log, on a piece of dry land which had been submerged two or three weeks before, whence it appears that it can exist a long time out of water. I had on several previous occasions failed to breed this larva to maturity, and the only imago I have was

obtained in 1861 from larvæ, which, suspecting them to be carnivorous from the very varied stations in which they had occurred, I had supplied with a number of fresh-water mollusks, but the habits of which, in consequence of having been away from home, I was unable to watch. On September 22, 1863, I found a nearly full-grown larva among floating rejectamenta, and between that date and December 23 he had devoured the mollusks of eleven univalves (genus Planorbis) from one-half to three-fourths of an inch in diameter; and on three separate occasions I have seen him work his way into the shell. In this operation his pseudopods were energetically employed, and I found, on cracking the shells after he had withdrawn, that a small portion of the tail end of the animal was left untouched—no doubt in consequence of his being unable to penetrate the small end of the whorl of the shell—and also the skin of the remaining part and the horny-tongued membrane.

My larva transformed to pupa within the ground during the fore part of July; it remained in this state but a few days and the fly issued July 13, and soon made its presence known by its loud buzzing inside the jar. It was a perfect specimen, and the pupal integument was sufficiently firm and polished, that by carefully washing off the earth an excellent cabinet specimen was obtained, which retained almost the exact form and appearance of the living pupa. Before the escape of the fly, which was effected through a longitudinal fissure on the back of the head and thorax, reminding one of the mode of escape of our harvest-flies (Cicadæ), this pupa by means of the horns with which it is furnished had pushed itself up to the surface of the earth.

The pupa (fig. 22, *b*) is nearly an inch and a quarter in length and a third of an inch in diameter. It is cylindrical, slightly curved, as in the figure, rounded at the head and tapering at the extreme hind portion. The abdominal segments are all but the first one provided with a ring of fine yellowish bristles, pointed backward. There is a stout thorn at the anal extremity, bearing six other thorns.

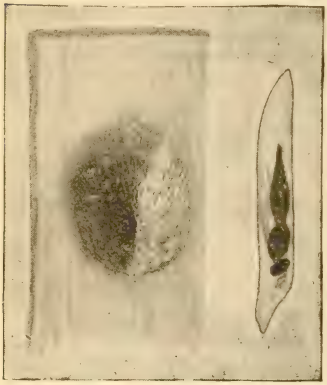


FIG. 24.—Egg mass *Tabanus atratus* and single egg containing parasite (from Hart).

The pupa state lasts but a few days and before the emergence of the fly it is pushed to the surface of the ground by means of the bristles and thorns of the abdomen, with bending movements of the body.

It splits along the dorsal line and the fly emerges leaving the pupa case in very perfect condition.

The adult fly (fig. 22, *c*) is an inch or more in length, black throughout, the back of the abdomen covered with a bluish white bloom and the wings smoky black. They are common through the summer months and it is possible from the different times that full-grown larvæ have been observed that there is more than a single brood in a year. It seems probable, however, that the winter is spent in the larval stage and that the full-grown larvæ observed by Mr. Walsh in September were simply late specimens that had lived over the previous winter and would have pupated the same fall, producing the flies a few days later, and these have laid eggs to pass the succeeding winter. Hart says the larvæ were taken every month of the season except June, at which time they had mostly reached the pupa or imago stage.

The habits of the adult have already been sufficiently stated, and as we have unfortunately no certain means of repelling them from cattle so as to prevent the bites, which is the only thing we need fear from them, a discussion of remedies is unnecessary.

It might be stated, however, that observations on the effect of tar and oil or other substances used to repel bot-flies would be of value in arriving at some method of preventing their attacks.

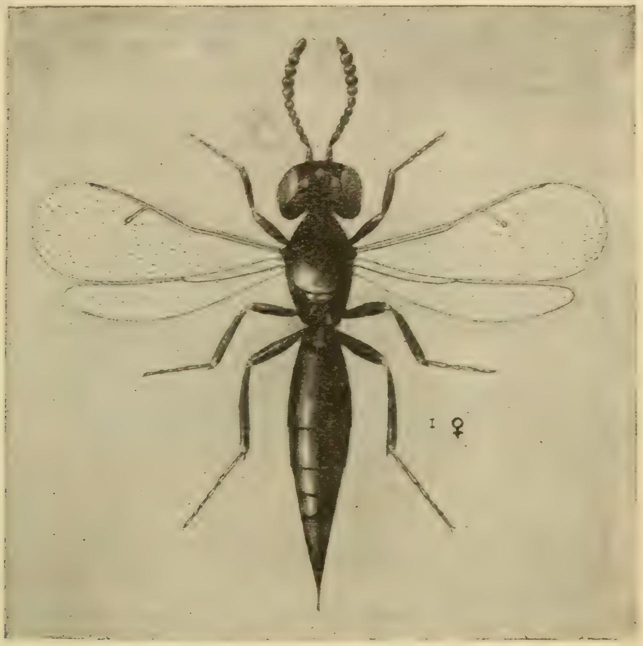


FIG. 25.—*Phanurus tabanivorus* Ashm. (from Hart).

Hart records the rearing of parasites, *Phanurus tabanivorus* Ashm., from the egg masses of this species. Also the apparent parasitization of a larva.

GREEN-HEAD HORSE FLY.

(*Tabanus lineola* Fab.)

This is generally regarded as the most common species in North America, and its occurrence in all parts of the country in large numbers fully supports such estimate.

While it must have been a familiar pest to the early inhabitants of the country, its first scientific description was given by Fabricius (Ent. Syst., Tom. IV, p. 369.)

Packard, "Guide to the Study of Insects," page 394, says:

> This fly is our most common species, thousands of them appearing during the hottest part of the summer, when the sun is shining on our marshes and western prairies; horses and cattle are sometimes worried to death by their harassing bites. In cloudy weather they do not fly, and they perish on the cool, frosty nights of September.

And also in "Our Common Insects," page 74:

> We were told during the last summer that a horse which stood fastened to a tree in a field near the marshes at Rowley, Mass., was bitten to death by these green-heads; and it is known that horses and cattle are occasionally killed by their repeated harassing bites.

This death of animals from bites must be very rare indeed, for in many years' residence in the Mississippi Valley, where the flies abound, the author has never known of such an incident, though the bites are certainly a great torment.

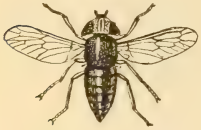


FIG. 26.—*Tabanus lineola* —(from Packard's Guide).

The flies are brown, with a tinge of reddish, and the abdomen has a conspicuous whitish line along the middle. The eyes are a brilliant green, from which the name is derived.

Hart has detailed the characters of the early stages as follows: "The larva of this species closely resembles the young of *nigrescens*, and was not separated from it at first." Examples of larvæ are said to have been collected in April and in June, pupæ in May, and imagoes in May and June. "The tabanid pupæ develop much more rapidly in hot weather than in cold, and to this fact is probably due the difference in time of emergence."

Larva: Length, 20 mm.; diameter, 2.7 mm. Prothorax with lateral shining areas about as long as the dorsal area, striation about the same as that of the upper mesothoracic area; no noticeable central smooth spot; a small one on lower margin posteriorly; remaining lateral areas a little more finely and closely striate; dorsal and ventral areas of thorax nearly smooth on disk, with basal striæ; those on abdomen with moderately close striæ, more or less interrupted on disk; all areas more or less shining.

Surface whitish, dull pubescent markings very light brown but distinct, annuli narrow, crests of false feet also dull pubescent, their sides striate; lateral stripes of thorax distinct, slender, not dilated posteriorly, lateral edges of dorsal areas of thorax diverging; an opaque dark ring about the base of respiratory tube, and another encircling anal prominence, above it usually three light-brown spots.

Main internal tracheæ rather thick and noticeable, subparallel, not strongly sinuate, at least back of the middle. Terminal stigmatal spine often protruded.

Pupa: Length, 19 mm.; diameter, 3 mm. Light ferruginous brown, shining, abdomen roughly wrinkled and subopaque. Palpal sheaths indistinct, not distant; tubercles not dark; ocellar tubercles indistinct or wanting; thoracic spiracular tubercles (fig. 28) slightly but nearly equally elevated, free margin rounded at tip, rima not vertical, evenly arcuate, slightly hooked in front.

Abdominal spiracular tubercles subtriangular, narrower behind, obliquely subconical, much shorter than basal diameter, bearing a small subcircular or short and strongly arcuate rima (fig. 29); on anterior slope a transverse groove, usually longer than the rima; fringes formed of unequal pale spines, only one or two long spines above on seventh segment; outer terminal teeth much longer than the others, directed laterally and upward, the tips of the four upper teeth about in line (fig. 30), fringe anterior to anal prominence showing a chitinous webbing

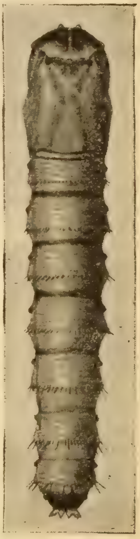


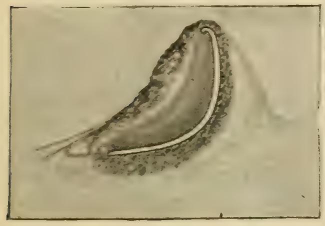
FIG. 27.—*Tabanus lineola*: pupa, dorsal view—enlarged (from Hart).

> between the bases of the spines, so that the separated tufts of the female look like a pair of broad, low teeth with several spiny points; lateral tufts low down, near ends of ventral fringe, formed of short spines.—(Hart.)

The species may be stated to have at least one natural enemy, for in the American Entomologist (Vol. II, p. 337) there is an account, by Mr. H. J. Dunlap, of their being eaten by the Nebraska bee killer (*Promachus bastardii* Macq.).

This account is of considerable interest, and we quote it herewith:

> *Champaign, Ill., August 6, 1870.*—I send you an insect by mail to-day in a glass bottle that has interested me for three or four years. I am hardly able to decide whether it is a friend or foe. My attention was first called to it by seeing several around my team during summer. Supposing them to be a new horse-fly, I watched to see one bite, but was finally rewarded by seeing it pounce upon a greenhead (*Tabanus lineola* Fabr.). It settled upon my sleeve and soon had transferred the contents of Mr. Greenhead's body inside its own by sucking the juices out by means of its stout proboscis. I saw this operation repeated many times. The present summer I have seen them dozens of times, often five or six around my team, and have always noticed that in an hour or so after they appeared no more horse-flies were to be found. I have also seen them "sucking" house flies, lady bugs, chinch-bugs, several moths, and have also seen them eat each other The one sent you had just captured a honeybee, for which offense I made a martyr of him (or her) for the benefit of science.



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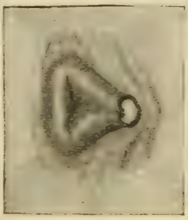

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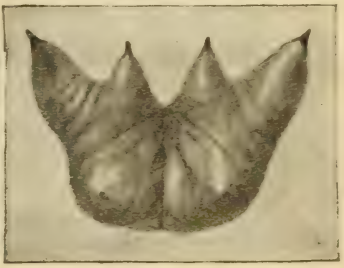

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FIG. 28.—*Tabanus lineola:* spiracular tubercle of pupa—enlarged (from Hart).
FIG. 29.—*Tabanus lineola:* abdominal spiracle of pupa (from Hart).
FIG. 30.—*Tabanus lineola:* end of last segment of pupa (from Hart).

THE GREENHEAD.

(*Tabanus costalis* Wied.)

This is another common species very abundant in the Prairie States, and was described many years ago. It is probably about as abundant and widely distributed as *lineola*, and causes a great amount of annoyance and suffering to domestic animals.

The following from Hart presents our present knowledge of the life history of the species:

> This seems to be normally a terrestrial larva. We have taken it two or three times in the earth of cornfields in Champaign County. The dates given are May 31 and June 4. Examples were placed in a breeding cage and an imago of *costalis* was secured from them.

The imago, known as the "greenhead," is very generally common, and is quite a pest in some bottom land prairies. A few examples were noted along shore at Station D, August 20. The examples in our collection were taken on twenty-two occasions, all between July 15 and August 13, except three dates, July 8 and August 18 and 31, which would make it probable that it is single brooded. The localities are Carroll Lake, Cook and Ford counties at the north, and Fulton, McLean, and Champaign counties in central Illinois. The specimens were from a variety of situations, usually in low herbage, often taken visiting flowers.

Larva: Length, 20 mm.; diameter, 2.7 mm.; prothorax with lateral shining areas about as long as the dorsal, coarsely striate, a smooth spot near center of disk; dorsal and ventral areas of thorax smooth, a few striæ on those of metathorax, especially posteriorly; remaining areas moderately striate, lateral areas of abdomen a little more finely striate than the others; all more or less shining.

Dark annuli pale, narrow, longitudinal stripes scarcely present; false feet with dull pubescent crests, their sides rather finely striate; a narrow dark annulus at base of respiratory tubes, another round base of last segment, inclosing anal prominence and giving off a pair of lateral stripes, the lower one longer; no projecting spines seen.

Pupa (from defective cast skin of male): Length, 20 mm.; diameter, 3 mm.; light fuscous brown, shining; abdomen smoothly wrinkled; slightly opaque; prothoracic spiracular tubercles slightly but nearly equally elevated, free margin rounded at tip, rima not vertical, evenly arcuate, slightly hooked in front.

Abdominal spiracular tubercles small, subtriangular, narrower behind, obliquely subconical, much shorter than basal diameter, bearing a very small subcircular ring; fringes formed of unequal pale spines, the longer ones sparse on seventh segment above; outer terminal teeth twice as large as lower pair, directed laterally and slightly backward; upper pair smallest, directed upward; ventral fringe of last segment not noticeably webbed; lateral tufts rather high, not near ends of ventral fringe.

My material of this species is not in best condition for accurate comparisons.

Tabanus annulatus Say.

This species was described by Say in 1822 (Jour. Acad. Phil., Vol. III, p. 31; Comp. Writ., Vol. II, p. 53), and its territory stated as Missouri. It does not seem to have received special notice since.

It is probably not abundant enough to cause serious annoyance to stock or is commonly confused with some more common species and has consequently received little attention.

It is smaller than *Tabanus lineola*, the length of the body being a little more than two-fifths of an inch.

It is of a leaden-gray color tinged with reddish; the abdomen blackish brown with gray margins to the segments, the wings without spots and slightly dusky. (From Say's description.)

Tabanus stygius Say.

This species is almost as large as *Tabanus atratus* Fab., nine-tenths of an inch in length and occurs in the Mississippi Valley. Say's description in 1822 (Jour. Acad. Nat. Sci. Phil., p. 33) locates it in Arkansas.

It is violet black and with the thorax pale chestnut. The front of the head is yellowish, the thorax with five gray lines, the wings rusty with three brown spots. (From description of Say.)

It is fairly common at Ames, Iowa, but has not been observed as especially annoying to stock. It has a wide range, however, and deserves to be studied with reference to its early stages.

Hart gives the following facts concerning the species, with descriptions of early stages:

> The present species was the most abundant tabanid larva in the vicinity of Havana last spring (1895) It first appeared in our collections September 14, when a number were noted swimming amidst vegetation near the margin at Station B. In the spring they were found at nearly all of the stations, but more particularly in connection with tipulid, muscid, and Eristalis larvæ, in matted accumulations of dead stems and leaves over mud. They were especially abundant March 30 in Flag Lake, where large plump larvæ appeared at every turn. It was a surprise to find a few of them upon the bottom in open, shallow water, far from shore, in the middle of Quiver Lake at Station A. Young larvæ have been common in connection with larvæ of Bittacomorpha and Limnophila at Station I since March 17. At Stations B and G they have been common in moist drifts of fine rubbish washed up by waves Pupæ were found in the breeding cages May 10 and 23. One emerged May 27 and another tried to emerge June 2, but died and was removed from its case.
>
> The larvæ resemble those of the *lineola* group in their striation and coloration, but differ in their short lateral prothoracic areas and larger size. They are like *atratus* in size, but may be readily separated from it by their coarser lateral striation, straw-yellow tint, slender lateral vittæ, and usually projecting terminal stigmatal spine.
>
> Larva: Length, 45–55 mm.; diameter, 6–7 mm.; bright straw yellow, varying in some young larvæ to nearly clear white, marked with light fuscous brown microscopic pubescence, usually paler at each stage than *atratus*.
>
> Lateral prothoracic striated areas not more than half as long as the dorsal, striation not finer than that of the middle and lower lateral areas of the mesothorax, striated portion shining; a small smooth spot adjoining the impressed line below; remaining upper thoracic areas a little less closely striated, but not strongly different from that of the prothorax; abdominal lateral areas a little more finely striate; dorsal and ventral areas with margin striated, disks nearly smooth in adult larvæ, last segment more strongly striate, especially beneath.
>
> Dark annuli distinct, broad, including false feet, a distinct, transverse dorsal and ventral pale spot in front of the false feet; abdominal annuli often with a small triangular backward prolongation on median line above. Prothoracic lateral space occupied by a pale brownish fuscous quadrate spot in front of the striated space. Meso- and meta-thoracic lateral stripes usually distinct, but slender, scarcely dilated posteriorly, lateral edges of dorsal areas diverging; lateral stripes above the abdomen almost wanting, except on last two segments. In these stripes the punctures of the upper and lower rows are indicated by rounded pale dots, and those of the inner rows by elongate dots. Last segment with bases of respiratory tube and anal prominence encircled with dark rings, joined by a lateral connection, its dorsum with at most a short basal line or pair of dots on each side. Coarser pubescence of false feet tipped with pale brownish.
>
> Main internal tracheæ thick and noticeable, especially in young larvæ, lustrous, subparallel, not strongly sinuate, nearly straight posteriorly; terminal stigmatal spine dark reddish brown, smooth, usually protruded (fig. 32, p. 68).

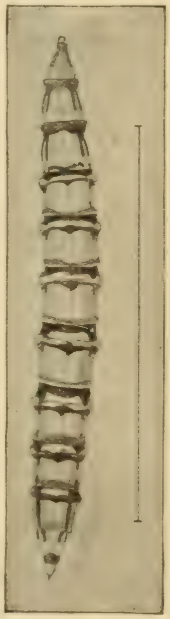

FIG. 31. — *Tabanus stygius:* larva (after Hart).

Pupa ♀: Length about 30 mm.; diameter about 6 mm.; light brownish fuscous, thorax paler, shining; abdomen roughly transversely wrinkled and subopaque. Palpal sheaths distinct, as far apart as are the setæ borne by the larger tubercles at the center of the anterior surface of the head; surface between them rounded, bearing a small wrinkled tubercle at middle; antennæ and tubercles darker than surrounding surface; ocellar tubercles distinct; prothoracic spiracular tubercles slightly but evenly elevated in a plane parallel with that of the surrounding surface; rima nearly straight in its outer half, inwardly curving strongly forward and ending in a conspicuous hook; free margin of tubercles rounded at tip.

First abdominal with two distinct setæ each side above the spiracles; abdominal spiracular tubercles rounded, broad behind, low, subhemispherical, rima long, following posterior border of tubercle, slightly curved at middle, more strongly curved forward at each end; on anterior surface a transverse groove extending across the tubercle, but not as long as the rima. Fringes of unequal spines, often tipped with blackish, all but two of the long spines wanting in a broad space above on seventh segment. Terminal teeth nearly equal, tipped with blackish, their points marking the angles of a hexagon, slightly wider than high. Ventral fringe of last segment not webbed together; lateral tufts high, on a level with upper lateral line.

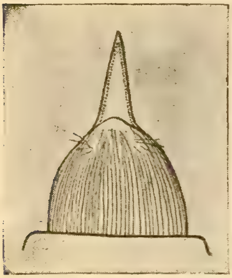
FIG. 32.—*Tabanus stygius:* last segment of larva, side view, showing projecting spine—enlarged (from Hart).

Tabanus molestus Say.

In describing this species in 1822 (Jour. Acad. Phil., Vol. III, p. 31; Comp. Writ., Vol. II, p. 53) Thomas Say states:

> This is one of the species that are called prairie flies. It is numerous in the prairies of the State of Missouri and is very troublesome to the cattle. I have seen cattle in the forests which margin these prairies when attacked by these insects start suddenly and plunge into the thickets that the branches may divest them of their enemies. Travelers are much incommoded by them; many cover their horses with canvas, etc., to shield them from their attacks, or rest in some shaded or secluded situation during that part of the day when they are the most abundant.

No special mention is made of it in subsequent works, but we know it to be fairly common in the Mississippi Valley. Say's account probably covers territory outside of the present State of Missouri; and Wiedemann (vide O. S. Cat., p. 22) is authority for its occurrence in Kentucky.

It is a rather large species, nearly four-fifths of an inch long; the thorax gray, with brown lines; the abdomen black-brown with a gray central stripe which is widened on the middle segments and consists of triangular spots on the fourth, fifth, and sixth segments.

EUROPEAN GAD-FLY.

(*Tabanus bovinus* Linn.)

From the statements of European writers this is apparently *the* gad-fly of Europe, or at least the one which is particularly troublesome to cattle.

According to Linnæus (Syst. Nat., Turton Transl., Vol. III, p. 67), it inhabits Europe, and is extremely troublesome to cattle.

The eyes are greenish; back of abdomen with white triangular longitudinal spots.

The early stages of this species were traced by De Geer (Mem. Ins.), who found the larva to be terrestrial and carnivorous. His observations on this species were the first giving information upon the early habits of the Tabanidæ.

THE BANDED BREEZE FLY.

(*Therioplectes cinctus* Fab.)

The banded breeze fly, or orange-belted horse-fly, is a species of somewhat larger size than the greenhead. It is rather less abundant than the black breeze-fly, which it somewhat resembles, excepting the orange or reddish band on the abdomen. It is limited more to the Eastern States. It was described by Fabricius at the same time as *Tabanus atratus* (Ent. Syst., Vol. IV, p. 366).

Hæmatopota pluvialis Linn.

According to Kollar this is one of the most troublesome species. He says:

> It is not much larger than the common horse-fly, and is chiefly distinguished by its large green eyes, through each of which run four brown undulating bands.
>
> The body is gray with brownish cross stripes; the wings gray with brown spots. It frequents meadows and pastures and attacks horses and horned cattle in sultry weather before rain, nor does man escape. Although the wound it inflicts is sharp, it does not produce any lasting itching or burning.

This statement regarding the injury caused does not agree entirely with the statements of other authorities, for in Kirby and Spence's Entomology (p. 93) we find a quotation from MacLeay which reads as follows:

> I went down the other day to the country, and was fairly driven out of it by the *Hæmatopota pluvialis*, which attacked me with such fury that, although at last I did not venture beyond the door without a veil, my face and hands were swollen to that degree as to be scarcely yet recovered from the effects of their venom. I was obliged on my return to town to stay two days at home. Whenever this insect bites me it has this effect, and I have never been able to discover any remedy for the torture it puts me to.

Also, in Linnæus under the description of the species:

> Like *T. cæcutiens*, this little insect fixes on the hands, face, and legs, exciting a painful inflammation in the part where it has drawn blood.

THE EAR FLY.

(*Chrysops vittatus* Wied.)

This is a rather small species, yellow in color, with black stripes and a broad, smoky band across the middle of each wing. It was described in 1821 by Wiedemann, but without reference to its habits.

It is said to be very troublesome in the wooded regions of the Mississippi Valley, directing its attacks particularly upon horses' ears, in consequence of which it is commonly called the "ear-fly."

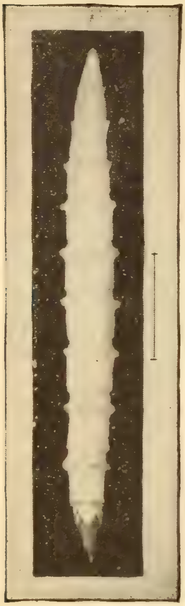

Fig. 33.—*Chrysops vittatus:* larva (after Hart).

Chrysops univittatus Macq.

This is a common species in the prairie region and is recorded from District of Columbia, Maryland, Connecticut, New Jersey, and Kentucky by Osten Sacken. It appears to be the most common species at Ames, Iowa.

Chrysops niger Macq.

A similar species, black in color; also very common.

Chrysops quadrivittatus Say.

Say described this species in 1822 as inhabiting the region near the Rocky Mountains. It is of a gray color, with four longitudinal brown lines on the thorax. The wings have a large brown spot on the front margin. It is nearly two-fifths of an inch in length.

Chrysops costatus Fab.

Occurs in South America and the West Indies.

Chrysops fugax O. S.

This species, easily recognized from the figure, is widely distributed. Osten Sacken recorded it from Maine, New Hampshire, Canada, Idaho, Montana, and Yukon River. It occurs at Ames, Iowa, and doubtless throughout the northern Mississippi Valley at least.

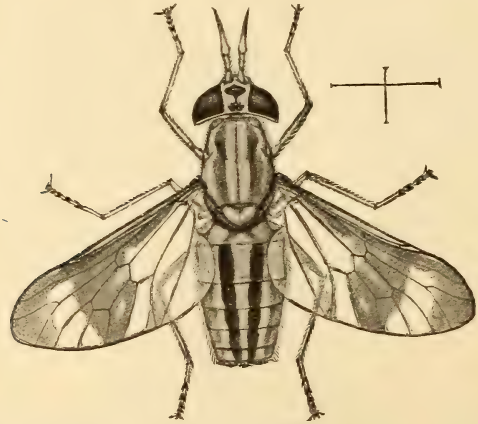

Fig. 34.—*Chrysops univittatus* (original, from drawing by Miss L. Sullivan).

The Hippoboscid-like Tabanid.

(*Goniops hippoboscoides* Aldrich.)

Under the above name Mr. J. M. Aldrich has described a very peculiar fly, that has the structure of the tabanids, but the general appearance of a hippoboscid, although it is not known but only surmised that it may have a parasitic or semiparasitic habit.

Since nothing is known as to the habits or the early stages of the species, and it would seem to be of very rare occurrence, it will suffice for the purpose of this paper to simply refer to the original description and figures (Psyche. Vol. VI, pp. 236, 237).

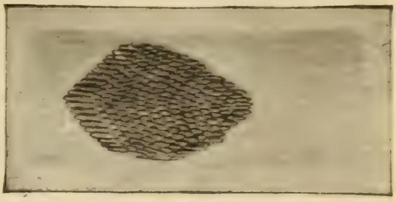

Fig. 35.—Egg mass of *Chrysops æstuans* (from Hart).

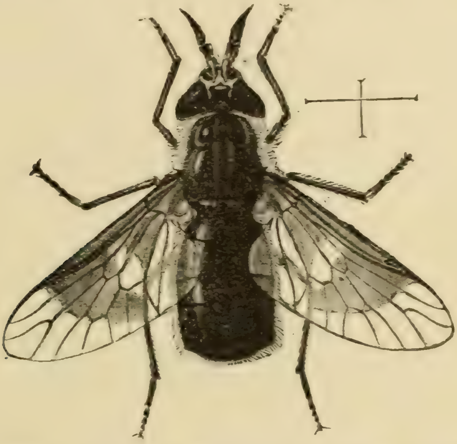

Fig. 36.—*Chrysops fugax* (original, from drawing by Miss L. Sullivan).

Family LEPTIDÆ.

(Snipe Flies.)

Most of the species in this family are of medium size, with rather slender bodies, and the abdomen generally somewhat tapering. They are sparsely haired; the head short; the eyes in the males set close together; the antennæ short, and the third joint with a terminal bristle or slender style.

The larvæ are carnivorous and live in the ground or else in decaying wood, in sand, moss, or water.

The species generally prey upon other insects, but according to Dr. S. W. Williston "some Western species of Symphoromyia suck blood, as do the horse-flies."

As he does not particularize as to the species observed, the animals attacked, or the method of attack, we must let this brief mention suffice.

Family ŒSTRIDÆ.

(Bot-flies, Breeze Flies.)

The bot-flies form a distinct family, easily recognized in larval or adult stages. The adults are heavy-bodied insects, generally rather hairy, and characterized by the small eyes standing at the sides of the head, the small antennæ sunken into deep pits on the front of the head and by the rudimentary mouth parts.

The larvæ are thick, fleshy grubs living parasitically in various portions of the bodies of mammals, the alimentary canal, the subcutaneous tissue, nasal passages, etc. The tracheal openings are located at the posterior extremity and protected by horny plates.

Frequently the segments are provided with rows of spines which serve to assist the animal in locomotion. The pupa stage is passed in the ground, the parasite leaving its host and entering the ground for this purpose upon attaining its full larval growth.

From the manifest economic importance of the different species and the great interest attaching to the habits of the species, which depart widely from even the most nearly related forms, they have been the subjects of investigation from the earliest periods of scientific work. The habits in general of the more common species were known more than a century ago and stated in the works of Linnæus, DeGeer, Reaumur, and others, while the later studies, early in the present century, by Clark and afterwards by Joly, Brauer, and others, have cleared up most of the essential points in their life history.

For the most part, these must be stated in detail for each species, since the habits are very different among the different species, and particularly so in the different genera.

In all cases the eggs are deposited on the animal to be infested, either where the larvæ will gain access to the proper part, or in direct contact with the parts to be invaded.

In one case, at least—the sheep bot-fly—the eggs may have already hatched and the free larvæ be deposited by the female.

Studies of the young larva have been attended with some difficulty, though in the later stages they are well known and were accurately described at an early day. The full life of the larva has been a subject of study by Joly and especially by Brauer, who presents in his "Monographie der Oestriden" a very careful discussion of the subject. A translation of this part has been published by Mr. B. Pickmann Mann (Psyche, Vol. IV, pp. 305–310), and the following extracts from this translation will be of such service in gaining a full understanding of the early life of the bot-flies in general that it seems desirable to include them:

> The larvæ of the Œstridæ, although in many cases quite peculiarly shaped, are so nearly related to the larvæ of the rest of the Muscidæ-calyptra that it has not yet been possible to discover for them a constant distinguishing character founded upon their structure. The reason of this lies in part in the œstrid larvæ themselves, since

they are very different among themselves, and in part also in our defective knowledge of the muscid larvæ.

At present, it is true, no real muscid larvæ are known with large thorn-warts—as I will call the dermal formations which occur in many œstrid larvæ, which are conical, soft at the base, fleshy, and corneous at the tip—also none with the characteristic stigmatal plate of the Gastrophilus larvæ; on the other hand, very many are known with thorns, like those of Dermatobia, or naked, like those of the young Hypoderma, or with horny stigmatal plates, like those of Cephenomyia. The remarkable parasitic method of life in mammals can probably be looked upon as peculiar to the Œstridæ. I leave it, therefore, to a future observer to establish a character for the œstrid larvæ whereby they may be distinguished from all other muscid larvæ, and limit myself here to the description of the larvæ according to genera and species.

The œstrid larvæ belong to the great division of those dipterous maggots which have been called headless, since they are segmented throughout and the usual regions of the insect body are not separated. Only a cephalic and an anal end, therefore, can be distinguished on the annulate body of such larvæ. In general the following common characters and peculiarities of the œstrid larvæ can be specified.

(1) The body of all œstrid larvæ is really composed of twelve rings. The first two are, however, not always distinctly separated, so that I take them together in the description, and designate them both by the name of cephalic ring, on which in many cases an anterior and posterior section is clearly to be distinguished. On that account I assume only eleven segments, as earlier authors have done. Only the new-born larvæ of Gastrophilus make an exception to this number; they, if Joly's statement is correct, possessing thirteen segments.

(2) Two anterior, external breathing organs are always to be distinguished on the larvæ, between the first and second segments of the body, and two posterior, external breathing organs on the last ring. The former are very small and appear either as points, knobs, or fissures, or the anterior ends of the tracheæ are hidden entirely in a cylindrical invagination of the skin (Gastrophilus). The posterior breathing organs are either breathing tubes which are protrusile and retractile (new-born Gastrophilus larvæ [p. 36] and Cephenomyia larvæ), or large stigmatal plates which are constructed according to two kinds of types. One of these types is represented in Gastrophilus and Dermatobia, the other in the rest of the genera. The stigmatal plates are more or less protected by lip-like organs on the last ring or by withdrawal into the preceding ring, and are in this way cleaned from substances which adhere to them.

I have described in detail under that genus the structure of the posterior stigmatal plates in Gastrophilus. The majority of the genera possess, however, two stigmatal plates in a real sense, consisting of corneous chitinous substance on the last ring. Each ring is usually crescent-shaped or reniform, in younger larvæ even quite circular, and appears when magnified either as latticed with coarse meshes, finely porous or almost smooth, sometimes radially furrowed. On the inner border of each plate is in all larvæ in the third and in many in the second stage a thinner, membranous or knob-like place superposed or embedded, sometimes inclosed in the plate itself. The attachment of the trachea corresponds to this place on the inside. Since it usually has the appearance of an opening, and also has been taken for such, I call it the false stigmatal opening. It has not yet been ascertained without doubt that breathing goes on in such stigmatal plates, but it probably takes place through pores of the plate. It seems to me as if the plates were penetrable especially at the circumference of the attachment of the tracheæ.

(3) The new-born larvæ all possess external mouth parts; in the later stages larvæ with oral hooks and those without them are to be distinguished. An internal pharyngeal framework of various development always occurs; this incloses the membranous gullet and by its muscular structure is of essential service in the sucking of the larva. If oral hooks are present, they are connected with this by a joint.

Usually a ∪-shaped, bent chitinous plate is to be seen, whose open side looks upward; from the side it has the shape of a sitting butterfly whose large upper wing reaches far back and has the smaller, narrow under wing under it. Since the wings of the two sides are grown together firmly underneath, the whole pharyngeal framework appears like a flying insect, when the wings are bent apart from above, and with the base in a plane. The part lying more or less in front, which is to be found in the middle between the wings, and which really radiates out into these, or is united with them like a ligament, is what Schroeder van der Kolk calls the tongue bone.

In the pharyngeal framework, therefore, there can be recognized a body (Schroeder's tongue bone) and four wing-like processes, which often, again, consist of several parts. The body is connected with the wings posteriorly. It is always bent in a U-shape, and so that the open end looks upward, i. e., if other soft parts of its vicinity which also close this are disregarded (p. 37). Bent flat, it shows a more or less distinctly H-shaped chitinous plate, with very broad side parts, which—in full-grown larvæ—become confluent behind into a simple, broad plate, and only leave an oval hole in front of them for the passage of the discharge duct of the salivary glands, but posteriorly bear the four wing-shaped processes (two large upper, or in the outspread plate outer ones, and two smaller slenderer inferior or inner). On the anterior end of the body, in many genera, oral hooks are jointed to the short anterior side parts. In the anterior curved excavation of this lies in the membranous expansion a small corneous chitinous plate which is pierced like a sieve and whose nature has not yet been more closely investigated. It seems to me as if this plate lay at the outlet of the salivary ducts. It is especially distinct in Cephenomyia larvæ. It is wanting in several others.

In young larvæ, the pharyngeal framework consists only of two chitinous rods, which are united in front by a chitinous band. These chitinous rods radiate out behind in little wings. A (similar) pharyngeal framework occurs in all other muscid larvæ, and corresponds in the perfect insect to the chitinous frame of the proboscis. I have repeatedly convinced myself that such is really the case, since I have opened the coarctate pupæ of Cephenomyia and Gastrophilus before the emergence of the flies. Since, in these genera, as we will see later, the nymph is tightly inclosed by the puparium, it can be noticed how the already freed pharyngeal framework, which remains attached to the puparium, rests in the mouth fissure of the nymph, and is drawn out of it as soon as the nymph is taken away or the lower lid is lifted off. It is also easy to form an idea that the pharyngeal framework, together with its internal parts, corresponds to the proboscis of the fly if it is observed how other muscid or syrphid larvæ while alive project and withdraw this exactly as the fly does its proboscis.

In Hypoderma, the mouth parts undergo a retrograde metamorphosis from the second stage (after the first molt); the oral hooks disappear, and therewith all the external mouth parts, but the internal pharyngeal framework remains.

(4) The œstrid larvæ show antennæ (at least rudimentary ones) above the mouth parts; these have the appearance of corneous or usually membranous knobs, and in the latter case are provided with one or two ocelli-like points. Subulate, many-jointed antennæ, such as occur in many muscid larvæ, are never found.

(5) All possess an anus, which lies on the last ring, under the stigmatal plates, and is very small.

(6) They molt twice while they are parasitic. I have observed most closely the molting in Hypoderma larvæ of the second stage. In *H. diana*, the passage from this stage (p. 38) to the last one takes place about the beginning of February. If in a cutaneous muscle which is richly larded with such larvæ the capsules of those larvæ whose hinder stigmatal plates have the shape of the third stage, but are still clear yellowish-brown, are carefully slit open, the skin characteristic of the preceding stage, with the many little thorns heaped in groups, will be found either still partly attached to the front end of the larva or entirely dependent from the cephalic end or folded together along the dorsal side. The process of molting

seems to be entirely similar to that in the Melophagus larvæ; at least Leuckart states that the old skin in these is shoved together toward the cephalic end of the larvæ, and there remains attached. The Hypoderma larva, immediately after the molt, is pure white, very soft, and appears naked, since the thorns do not become dark and distinctly separated from their surroundings until they harden.

Three forms or stages are to be distinguished, corresponding to the molts, which forms in Hypoderma, Gastrophilus, and Dermatobia show great differences. In the third stage the larvæ reach their full size, usually change their color, and that often very considerably, and then first leave their host animal, crawl away and pupate, after the manner of the Muscidæ.

(7) This pupation must be considered as a third molting, in which, however, the skin is only detached around the pupa, but is not stripped off, and remains in connection with it by means of four tracheæ. The hardened larval skin, or puparium, is burst open at the cephalic end by the emerging fly by means of the frontal bladder filled with fluid, in the direction of the arcuate sutures in a double manner. Although the pupation resembles herein that of the Muscidæ in general, yet there occurs in one part of the Œstridæ, i. e., in Hypoderma, a peculiarity which has not been observed before, namely, that the larva transforms in the puparium in a completely outstretched condition, and this, therefore, is far larger than the insect which comes forth from it.

(8) So far as they have been observed, they lead a parasitic life in mammals, and feed upon the juices of these animals. In Hypoderma, a blood-red intestine often shows through, and it is likely that these sometimes suck up blood in addition to the exudation which immediately surrounds them.

(9) The closely observed larvæ all show at first a slow and finally a rapid development, so that there occurs a resting stage, which often lasts seven months, between the swarming of the imago and the first visible appearance of the larvæ.

The larvæ of the Œstridæ were formerly divided into two groups—into larvæ with oral hooks and those without external mouth parts. Such a separation is of service in distinguishing the full-grown larvæ, but scientifically unnatural and incorrect, since in the first place this peculiarity of the full-grown larvæ corresponds to no similar degree of relationship of the perfect insects, and in the second place it is only temporary (p. 39), since all œstrid larvæ possess oral hooks when they are quite young. Such a division also as Clark attempted to make into *cavicolæ*, *cuticolæ*, and *gastricolæ*, is inadequate, for while the species of a genus do, indeed, always agree in life history so far as their occurrence as parasites in a determinate organ is concerned, nevertheless the larvæ of very different genera may also share this same manner of life with others; for instance, Hypoderma, Cuterebra, Dermatobia, among which there is far more difference between one and two than between Cuterebra and Cephenomyia, if the imagoes are considered. Such a division is, therefore, likewise not a natural one, since it disturbs the natural relations of affinity. Two elements must be considered in order to bring about an approximately natural division: In the first place, the organization of the larvæ, and, in the second place, their manner of life, and the latter in a subordinate degree, though this is here more important than in other animals, since as yet there is no example of two species of Œstridæ of one genus having been found parasitic in different systems of organs. Thus the Cephenomyia larvæ belong to the œsophagus, the Cephalomyia and Œstrus larvæ to the nasal and frontal cavity, those of Gastrophilus to the intestinal tract, and those of Hypoderma to the subcuticular cellular tissue.

Although it is stated that the larva of Gastrophilus has been found in the œsophagus, this is one of the exceptional cases which are not authenticated. Of course, only the full-grown larva is meant here, since young larvæ may always be found in other places during the immigrations. So, for instance, the young Œstrus and Cephenomyia larvæ both immigrate in like manner through the nose, and their roads do not separate until they get there, but the former migrate into the frontal cavity and the latter into the œsophageal cavity.

Of the organs in which Œstridæ occur, the skin, or really the subcuticular cellular tissue, is that which is the most strongly attacked; the larvæ of four genera—Hypoderma, Œstromyia, Dermatobia, Cuterebra—live in it. The nasal and frontal cavity are inhabited by the genera Cephalomyia and Œstrus, the nasal and œsophageal cavity by the genus Cephenomyia, the intestinal canal by the genus Gastrophilus. The transformations of the other genera of Œstridæ are unknown.

It is interesting, further, that many genera occur only as parasites of certain families of mammals, while others have a somewhat wider or very wide range of distribution, and so have for hosts the different mammals, yet not quite without choice, and often even seek man for their breeding places.

Thus, until now, the larvæ of Cephenomyia have only been found in the throats of cervina, those of the genera Cephalomyia and Œstrus only in *tylopoda* and *cavicornia*, those of the genus Gastrophilus in *solidungula* and *multungula* (*Rhinoceros*), but Hypoderma, on the other hand, in *cavicornia* (Bos, Capra, Antilope), *cervina* (Cervus, Moschus), and *equida*, Cuterebra larvæ in Rodentia and Marsupialia, and finally those of Dermatobia in dogs, oxen, horses, and even upon man.

(p. 40) Another picture is formed if the perfect insects are divided according to a peculiar character into those with pectinate antennal bristles (Cuterebra, Dermatobia), and those with naked antennal bristles (Hypoderma, Gastrophilus, Cephenomyia, Cephalomyia), since the larvæ of the former are parasitic in ungulate animals as well as especially in Rodentia and Marsupialia, but those of the latter only in Ungulata. This hitherto so convenient and practical division likewise can not be relied upon for an inference, since *Œstrus leporinus* belongs to the group of Œstridæ with naked bristle, but its larva lives upon a rodent. It is seen that such divisions are only artificial and serve for orientation, but that nevertheless nature can not be forced into them. Such divisions are therefore only temporary, and only too often become untrue so soon as new discoveries are published. It is therefore best to treat of the larvæ according to their genera, and to limit these as natually as possible, since it has thus far been found constantly in this family that the larvæ of one genus all have a like life history, and conversely the generic characters of the imagoes can scarcely lead us astray if we wish to draw an inference as to the life history of a larva perhaps not yet investigated. In the case of a new genus, however, we can infer its life history with very little certainty. Experience alone teaches this.

The flies are seldom observed except in open sunny places and secrete themselves mostly in low herbage, grass, along roadsides, and other situations where they may gain ready access to their victims. Most or all of them live in this stage strictly without food, the mouth parts, except in a few, being very rudimentary or entirely wanting. All are confined in their attacks to vertebrates, and all, so far as positively known, to mammals.

The species are quite numerous, about sixty being known in the adult form, but only the more common ones have been thoroughly studied, and in our detailed discussion of the species we will give particular attention only to those affecting the common domestic animals.

THE HORSE BOT-FLY.

(*Gastrophilus equi* Fab.)

Bots in horses have been a familiar form of parasite to farmers, stockmen, and veterinarians for we know not how long. Whether they were familiar to the ancients has been a matter of discussion among

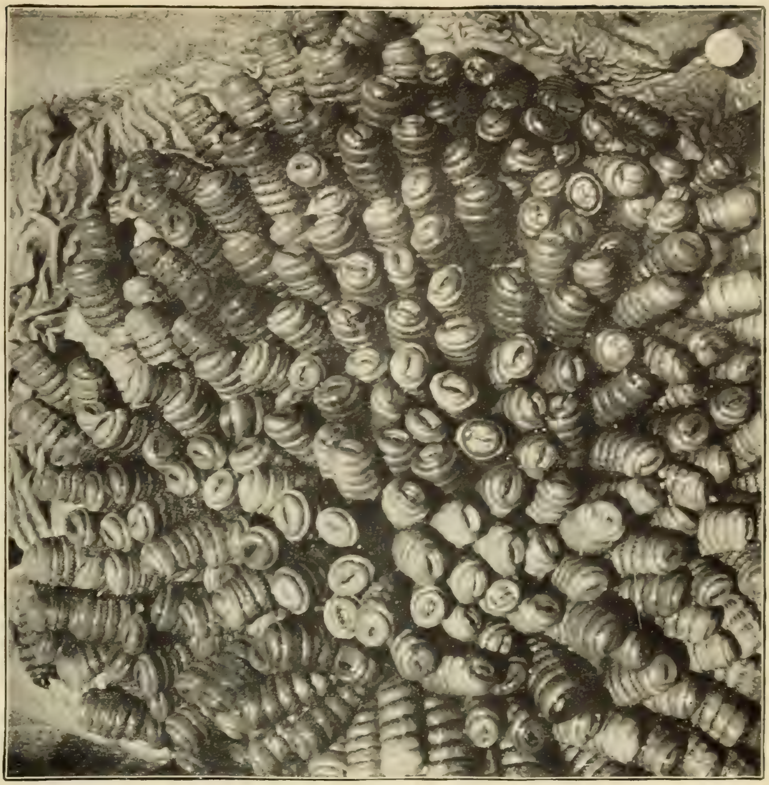

FIG. 1.

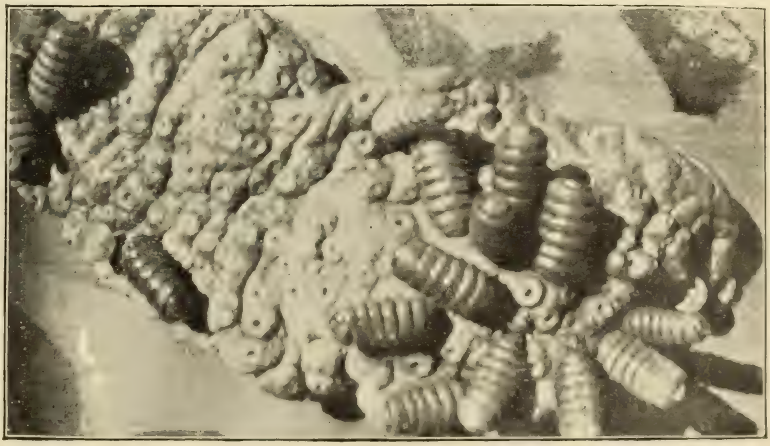

FIG. 2.

GASTROPHILUS EQUI IN STOMACH OF HORSE.

FIG. 1.—Bots on the walls of a horse's stomach. (From a photograph by the author.)
FIG. 2.—Portion of stomach wall showing points of attachment of bots. (From a photograph by the author.)

learned men, but the mention in ancient writings of the Œstrus and its habits is now generally considered as referable to some of the flies capable of piercing, such as the gad-flies or horse flies and not the bots. The occurrence of two or three similar species affecting the horse has led to some confusion in their names. Thus the *Œstrus equi* of Linnæus appears to correspond with the *Œstrus vituli* of Fabricius, while the latter author includes in *Œstrus equi* the *Œstrus nasalis*, *Œstrus hæmorrhoidalis*, and *Œstrus veterinus* of Linnæus. Without going into a discussion of this synonymy here, it will be seen that all of these forms were apparently familiar to scientific writers more than a century ago as well as the more striking features of their life history. Thus the statement made by Linnæus (Turton's translation, p. 582) reads as follows: "Deposits eggs on the hairs of horses, and always on those parts which are most liable to be licked by the tongue; these, either in the egg or larval state are conveyed by the tongue into the stomach, and passing through the intestines with the food are discharged with the dung." These larvæ are commonly known by the name of bots. In 1815 Mr. Bracy Clark published his essay on bots of horses and other animals presenting the results of thorough investigation upon these interesting parasites, and subsequent investigation has but confirmed in large part the conclusions reached by him.

NATURE AND EXTENT OF INJURY.

Different writers have placed very different estimates upon the injury due to bots, and as great diversity, or perhaps greater, exists in the opinions of practical men and veterinarians, some holding that the presence of the bot in the horse's stomach does not interfere with its normal activities, while others look upon them as extremely dangerous and sometimes refer almost any serious disturbance of the digestive organs, or death from unknown cause, to bots.

The injury to the horse from the larvæ may take four forms: (1) The attachment to the walls of the stomach causes an irritation which may interfere with the normal action of the glands or reduce the extent of glandular surface; (2) the bots abstract some nutriment from the walls of the stomach, or by absorption, from the contents of the stomach itself; (3) by collecting, particularly in the region of the pylorus, they serve as an obstruction to the free passage of food from the stomach to intestines; (4) in passage through intestines they may attach themselves at times to walls or in rectum and cause great irritation. Some consider this as the source of most of the serious symptoms from presence of bots. In any of these methods the extent of injury depends in large degree upon the number of bots present, a few probably causing no appreciable damage, while large numbers (sufficient, as we have seen them, to completely cover large patches of the stomach walls) must cause serious disturbance and loss of nutrition and would seem a sufficient cause to produce fatal results. From the nature of the case no definite statistics can be given for the losses incurred. It is probably safe to say that nine-tenths of all colts and horses that are pastured during summer, and a smaller proportion of driving and work horses, become infested with bots each year. Aside from the injuries inflicted by the larvæ, we must consider the excitement produced by the flies when depositing the eggs as a source of loss, and this in many cases is by no means insignificant.

LIFE HISTORY AND HABITS.

Adults of this species are about three-fourths of an inch in length, the wings are transparent with dark spots, those near the center forming an irregular, transverse band. The body is very hairy, the head brown with whitish front, thorax brown, abdomen brown with three rows of blackish spots, which are subject to considerable variations. In the females the segments are often almost entirely brown with simply a marginal series of yellowish spots, while in males the abdomen may be almost entirely yellow or very light brown, with brown or dark spots very distinct. The males are rarely seen, for while it is one of the most common occurrences to witness the female around the horses depositing their eggs, the males evidently hold aloof. They are readily distinguished by the form of the abdomen, which lacks the two tubular segments at the end, and is provided on the under side of the last segment with a pair of dark-brown or black hooks, or clasping organs. Otherwise, except the color of the abdomen, already mentioned, they resemble very closely the females. The eggs (fig. 37, *a* and *b*) are light yellow in color and will be found attached to the hairs of the shoulders,

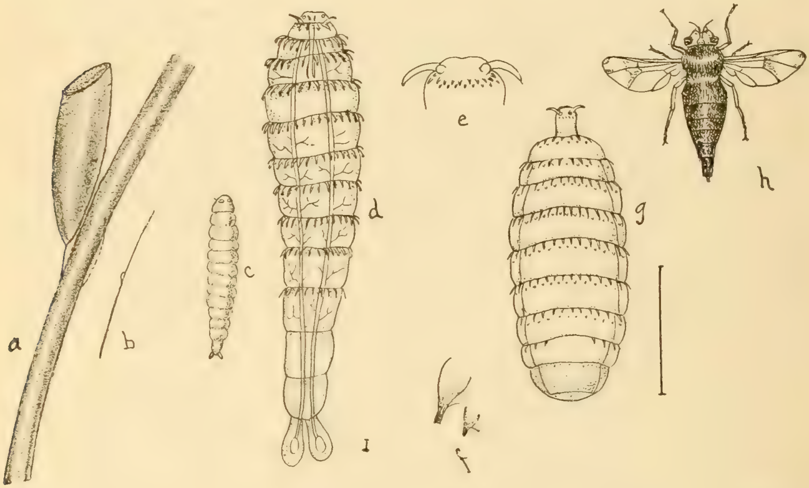

FIG. 37.—*Gastrophilus equi: a*, egg—enlarged; *b*, egg—natural size; *c*, young larva; *d*, young larva—much enlarged, showing spiny armature; *e*, oral hooks; *f*, body spines; *g*, full-grown larva—twice natural size; *h*, adult female (original).

forelegs, under side of body, and sometimes even the mane and other parts of the body, most commonly, however, on the forelegs and shoulders. The method of deposition has been frequently observed. The female hovers near the horse in a position which appears to be nearly vertical, since the body is bent downward, and the extended abdomen is thrust forward under the body to its full extent. The fly then darts toward the horse, the egg is glued to the hair in an instant and the fly retreats a yard or two to hover till another egg is ready to be deposited. The operation is repeated at very short intervals, so that hundreds of eggs may be deposited upon a horse in a comparatively short time. The eggs are held by a sticky fluid, which quickly dries and thus glues them firmly to the hairs. They are about one-sixteenth of an inch in length, and taper a little toward each end, though the attached end is the smaller. The outer end is provided with a little cap (operculum), which is set quite obliquely to the axis of the egg, though some authors represent it as cutting the egg square off at the end. This cap or operculum breaks or is pushed off when the grub hatches. Bracy Clark wrote that the eggs do not hatch until twenty-five to thirty days old, while Joly found them to hatch in four or five days. Verrill says:

> The eggs contain more or less perfectly developed larvæ when laid; and when they are mature or have been a few days attached to the hair, they burst open and allow the young to escape almost instantaneously, when moistened. Thus, when the horse licks itself or its companions, the moisture hatches the eggs and the young larvæ are transferred to the mouth by the tongue or lips, and thence to the stomach, where they fasten themselves to the lining membrane by their two hooks.

Evidently some such condition is essential to the hatching of the eggs, as we have removed hairs containing eggs from the horse and keeping them where not subject to moisture they failed entirely to hatch, and even after a year's time do not appear greatly shriveled. Doubtless they must hatch in a comparatively short time or lose their vitality, for moisture does not effect a hatching in those long kept away from the horse. The empty egg shells may cling to the horse for some time after the hatching of the larvæ and give it the appearance of being coated with eggs. Examination, however, will readily disclose the absence of the operculum in the hatched eggs.

In order to determine more certainly as to the exact condition of hatching and the time involved, I undertook in 1893 some observations which were reported in Bulletin No. 32 of the Division of Entomology (pp. 46–49). Eggs collected from a horse while flies were depositing, and therefore probably not long laid, were opened at different times by rubbing them with a moistened finger, simulating as nearly as possible the action of the tongue in licking the body. While the larvæ appeared to be fully formed during the first three or four days after deposition, the eggs hatched with difficulty and the larvæ seemed quite inactive, and all larvæ that were freed in this manner up to the tenth day were hatched with difficulty, though the larvæ at the end of this time were becoming fairly active.

Four weeks after hatching the eggs opened with the slightest touch of a wet finger, and the larvæ adhering to the finger were very active, though in some cases they were inactive and apparently dead. About five weeks after collecting the eggs nearly all gave only inactive or dead larvæ, though opened with ease on being touched with the finger, and in forty days after collecting no living larvæ could be found in the remaining eggs, except one which had succeeded in pushing off the cap of the egg and partially emerging.

In view of these results, I concluded:

(1) That the eggs of the horse bot fly do not hatch, except by the assistance of the horse's tongue.

(2) That hatching does not ordinarily occur within ten or twelve days and possibly longer, or if during this period, only on very continuous and active licking by the horse.

(3) That the hatching of the larvæ takes place most readily during the third to fifth week after deposition.

(4) That the majority of the larvæ lose their vitality after thirty-five to forty days.

(5) That larvæ may retain their vitality and show great activity upon hatching as late as thirty-nine days after the eggs were deposited.

(6) That it is possible, though not normal, for eggs to hatch without moisture or friction.

(7) That in view of these results, the scraping off of the eggs, or their removal or destruction by means of washes will be effective, even if not used oftener than once in two weeks during the period of egg deposition, and, probably, that a single removal of the eggs after the period of egg deposition has passed, will prevent the great majority of bots from gaining access to the stomach, or at least so large a proportion that little injury is likely to occur.

Wishing to know still more definitely the period of most ready hatching, and the effect of different washes for treatment, I suggested to a veterinary student, Mr. Harry Shanks, a careful series of observations, which were carried through during the summer of 1894.

From this study, which was made under my direction, and so that I had frequent opportunity to note progress, a number of points were gained, which are worth adding to the above record. Three hundred eggs were collected from a horse which had been previously freed from eggs, so that the exact date of deposition was assured. The eggs were tested every day.

On the day of collection (first day) the eggs appeared immature. One day later eight eggs opened by picking the operculum off showed three larvæ with slight movement, and five immovable. On the third day a half hour of friction failed to hatch eggs, but the larvæ when freed by picking off the operculum showed two, slight movement; one, no movement, and one sufficient movement to get out of the opened shell.

On the fourth day the larvæ in eleven eggs were all active, but had to be freed by picking off the operculum; the same was true up to the seventh day, the only difference being noted in greater maturity and size of larvæ.

On the ninth day, or when the larvæ were eight days from deposition, one larva was freed by seventeen minutes of rubbing with wet finger, another in twenty-two minutes; on the tenth day two others, one in fourteen and the other in eight minutes; and on the eleventh day several were hatched, the time varying from two to five minutes of subjection to the saliva and friction. On the twelfth day it required but one or two minutes, and on the thirteenth eggs would hatch in fifteen to thirty seconds. On the fourteenth day a number of eggs were tried, about one-third of which hatched almost immediately upon being touched with the moist finger, the others in from five to eight seconds. On the fifteenth day all eggs seemed fully mature, and probably nine-tenths would have hatched at once upon being touched by a horse's tongue in the ordinary motion of licking. From the sixteenth day to the twenty-second the eggs would open with a touch of the finger, but the larvæ would not adhere except with moisture. On the twenty-third day the first dead larva was noted, and a day later four out of eleven eggs opened had dead larvæ. On the twenty-fourth day all of the eggs not previously opened were examined with a lens, and only one showed the cap removed, the larva being partly out, but dead. The hatching of but one egg out of three hundred seems to me to establish pretty fully my former opinion, that the eggs require moisture or friction for the release of the young.

On the twenty-fifth day, out of 10 eggs three contained dead larvæ, five could move slightly, and two were quite active. On the twenty-sixth day caps were removed from thirty-five eggs, twenty-seven larvæ being dead, seven were capable of slight movement, and one was active enough to escape from the shell.

On the twenty-seventh day out of forty-three eggs opened only one larva was alive, and on the twenty-eighth day only one out of sixty-five, and on the twenty-ninth day all the remaining eggs, one hundred and three, showed only dead larvæ.

The results of this study, it will be seen, confirm in the main the conclusion of the former observations, the principal difference lying in the fact that all the larvæ were dead at a somewhat earlier period. Of course it could not be said that of the eggs opened in the earlier days none would have survived longer than four weeks, but considering the number used and that one-third of them were kept the full four weeks and two-thirds nearly that long before being opened, the presumption is strong that that is the full normal period of survival.

It is safe, I think, to sum up the matter by saying that the eggs normally require friction and moisture to permit of their hatching and transfer to the horse's mouth, that hatching occurs with difficulty before the tenth day, and most readily after the fourteenth day, and that they lose vitality at a period varying between the twenty-eighth and fortieth days, the bulk not surviving more than four weeks. This gives a solid foundation upon which to base recommendations as to the time when eggs must be destroyed.

The newly hatched larva (fig. 37, *c*) is a slender, worm-like creature, so transparent that the internal organs are plainly visible. It grows rapidly at first, its food consisting, probably, of the mucous secretions of the mouth and œsophagus. When two days old it presents the appearance shown in fig. 37, *d*. As soon as it reaches the stomach it fixes itself to the walls by the hooks next the mouth and soon undergoes considerable change in its form and appearance. The body becomes more conical, but instead of the head end being widest this becomes more slender, while the tail end broadens. The spiracles at first exposed in two flap-like projections from the last segment are drawn more within the body and are protected by the development of a horny plate. The spines on the segments following the head become more pronounced. When full grown the larva is three-fourths of an inch to one inch in length and of the appearance shown in the accompanying figure (fig. 37, *g*). At this time they occur in large clusters upon the walls of the stomach, generally more especially numerous at the pyloric portion, where they serve to retain the contents of the stomach. From the fact that the food of the horse does not become completely reduced to fluid, this obstruction may be considerably greater than if only fluid matter had to pass the pylorus. This growth has occupied from late in the fall, through the winter, till late in the spring, and when fully developed the bots loosen their hold and are carried through the intestines and, escaping with the excrement, burrow into the ground to pass the pupa stage. This lasts for several weeks, thirty to forty days, according to some authors, when the fly, which has been already described, issues and is ready to proceed with the business of providing for another generation of bots.

The larva of this species has been found in the stomach of the dog, though it can not be considered a normal habitat for it, and it is very doubtful whether the young larvæ could survive in the stomach of a carnivorous animal. Railliet (Comptes Rendus des séances de la Société de Biologie, 1894) cites records by Colin and others of such occurrences, and details experiments which show the possibility of the survival of nearly mature larvæ that are swallowed with fragments of the stomach walls attaching to the stomach of the dog and remaining alive and healthy fifteen days after the ingestion.

PREVENTION.

In dealing with bots in horses, by far the most important point is to prevent the introduction of the larvæ, and while we have no opportunity, as in the case of the ox bot-fly, to completely exterminate the pest, it is certain that proper attention to preventive measures would in a few years greatly reduce the numbers of the insect and procure comparative freedom. The better care usually accorded horses makes it possible to deal with it in some respects more easily than the species infesting cattle. The most vulnerable point of attack lies in the conspicuous position of the eggs. No horseman, probably, can overlook these objects when occurring on the horse he is caring for, and colts in pasture sometimes become so covered with them as to give a decided change in color to the parts most affected. It is evident that removing or destroying these eggs previous to hatching is all that is necessary to prevent "bots" in the horse. With horses kept in stables or used daily there is little trouble; the flies have less opportunity to deposit eggs upon them, and the ordinary grooming of the animal serves to remove some of the eggs, or being constantly under observation the eggs attract the attention of the person in charge and he removes them, if not to prevent bots at least to avoid the unsightly or ill-kept appearance they give the animal. With colts or horses in pasture, however, the case is very different. Not knowing the currycomb or card through the whole summer, and perhaps hardly seen from one week's end to the other, the eggs deposited on them by hundreds have every possible chance to transmit larvæ to the alimentary canal where they commence their growth. During July, August, and September, or as late as eggs appear on the horses, those kept in pastures should be examined once every two or three weeks and the eggs destroyed or removed. This can be accomplished in several ways. By using washes of dilute carbolic acid, about one part carbolic acid to thirty parts water, or rubbing the affected parts over lightly with kerosene, by clipping the hair or by shaving the eggs off with a sharp knife or razor. Our own experience leads us to prefer the last. With a very sharp knife or razor (a dull one will glide over the eggs) the affected parts can be very quickly run over without removing much, if any, of the hair. This method leaves no doubt as to whether or not the eggs have been touched, as in washes, and subsequent examinations are not complicated by a lot of dead eggs or shells. Perform once every two weeks, and there can be very few of the larvæ which gain entrance to the stomach. Will it pay, may naturally be asked by the man who has, say, from twenty-five to a hundred colts in the pasture. Possibly not, if but a single season is considered, but the loss of a single horse, or the poor condition of a number, resulting from bots, or the fretting of the whole number in pasture, would more than equal all the cost of removing the eggs from the entire lot. But when the presence on the farm of the pest year after year is considered with all its attendant evils, we believe most emphatically that it will pay.

Quite frequently the flies will be observed at work depositing eggs on the legs or body of a horse at work or in carriage. If not noticed at once the nervous stamping, biting, or often greater excitement of the horse will apprise the driver of their presence. Although the flies are pretty wary and dart away when approached, a few seconds' watching will enable one, by striking them down to the ground with hand or hat, to capture and kill the fly and thus stop the deposition of eggs and annoyance to the horse. Whether the larvæ of this species can mature except upon gaining access to earth seems not to have been determined, and for all the time the horses are in the field or on the road they have ready access to earth. But as some other forms can pupate successfully in the dung heap, it would seem worth while to subject the droppings of horses known to contain bots to some process that would destroy them and thus prevent maturity of the fly.

REMEDIES FOR BOTS.

The prescription of drugs for the removal of bots from the stomach when their presence is known or suspected belongs rather to the veterinarian than to the entomologist, but it may not be out of place here to call attention to a few of them. It is of course not an easy matter to determine during the life of the horse whether any particular disturbance of the digestive organs or lack of nutrition is due to the presence of bots or to some other agency producing similar symptoms, and even a competent veterinarian may be puzzled in diagnosis. If occasional bots are noticed in the excrement of the animal together with poor condition, their presence in numbers may be inferred. It must be remembered that the bots are capable of withstanding almost any substance that the walls of the stomach can endure, and the safest plan, if intending to dose for them, is to employ a veterinarian. Turpentine is perhaps most generally given, but must be used with care.

THE HÆMORRHOIDAL BOT-FLY.

(*Gastrophilus hæmorrhoidalis* Linn.)

While it is common to speak of *the* horse bot fly, it should not be inferred that there is but one kind parasitic upon the horse. Take the world over there are at least six well-defined species occurring on the horse, ass, or mule, and any of these are liable to be introduced into this country with imported animals. The above-named species is probably next to *equi*, the most generally distributed in this country. With the other allied species it was well known in Europe during the last century and received mention or more elaborate description from Linnæus, DeGeer, Fabricius, and other leading writers on entomology.

EXTENT OF INJURY.

The losses to be referred to this species are similar to those of the other species, but from the accounts of various authors and what we have heard from persons who were plainly describing the actions of this particular form, it is evident that the excitement and consequent loss due to the attacks of the adult fly are much worse with this species than the common one. This is described by Clark as follows:

> At the sight of this fly the horse appears much agitated, and moves his head backward and forward in the air to balk its touch and prevent its darting on the lips; but the fly, waiting for a favorable opportunity, continues to repeat the operation from time to time; till at length, finding this mode of defense insufficient, the enraged animal endeavors to avoid it by galloping away to a distant part of the field. If it still continues to follow and tease him, his last resource is in the water where the

Œstrus is never observed to follow him. At other times this Œstrus gets between the forelegs of the horse whilst he is grazing, and thus makes its attack on the lower lip. The titillation occasions the horse to stamp violently with his forefoot against the ground, and often strike with his foot, as if aiming a blow at the fly. They also sometimes hide themselves in the grass and as the horse stoops to graze, they dart on the mouth or lips and are always observed to poise themselves during a few seconds in the air, while the egg is preparing on the point of the abdomen.

LIFE HISTORY AND HABITS.

Having discussed pretty fully the habits of the common species, it will be unnecessary to go into details that are similar in other species, but simply call attention to distinguishing characters and such differences in habit as may be of economic importance.

Prof. A. E. Verrill (Report on External and Internal Parasites of Man and Domestic Animals, p. 29) gives the following condensed statement of its life history and habits:

> The *Gastrophilus hæmorrhoidalis*, or red-tailed bot-fly, is a small species, easily distinguished by the bright orange-red tip of the abdomen. The thorax above is olive gray and hairy, with a black band behind the suture. The base of the abdomen is whitish and the middle blackish, in strange contrast with the orange red of the end. The larvæ have the same habits and are found in the same situations with those of the common bot-fly, which they much resemble, except that they are whiter and smaller, their length not exceeding one-half or five-eighths of an inch. They change to pupæ within two days after leaving the horse, and the pupæ are deep red. They remain in the pupa state about two months, and the flies appear from the last of June till the cool weather of autumn. In depositing the eggs the female differs in habit from the common bot-fly, for she selects the lips and nose of the horse as the most suitable place for this purpose. The eggs are darker colored [some authors say black] than those of the common bot-fly, and contain a nearly developed embryo, so that they very soon hatch, and the young larvæ are transferred to the mouth by the tongue, and thence get into the stomach.

REMEDIES.

On account of the shorter time between deposition of eggs and hatching of larvæ, it is evident that the removal of eggs as for that species would be less successful. For horses in use, immediate attention when they give signs of the presence of the fly, the capture of the insect and the removal of eggs already attached would be but the natural method suggested by a knowledge of the insect. For horses in pasture, if exhibiting signs of molestation by this insect, the same attention would be advisable whenever the nature of the case will permit. It would be worth while to try the application of some oil or tar to the hairs of the lips as a prevention to the fastening of the eggs to them.

HORSE BOT-FLY OR "CHIN FLY."

(*Gastrophilus nasalis* Linn.)

As already stated, this species has been more or less confused with *equi* in scientific writings and doubtless still more so in general observation.

It was described as *Œstrus nasalis* by Linnæus (Fauna Suec.) and it was also given the name of *veterinus* by Clark. It was included by Fabricius with *hæmorrhoidalis* under *Œstrus equi.* The description in Systema Naturæ (Turton's translation) is as follows:

> Wings immaculate, body ferruginous, sides of the thorax and base of the abdomen with white hairs. Deposits its eggs on horses and cattle, the larvæ probably pass through the stomach like the former one.
>
> Less than *Œstrus equi.* Insertion of the wings and base of the abdomen covered with whitish hairs; second segment of the abdomen with two hairy tubercles. Beneath and legs rusty brown. Female with sometimes a blackish abdomen.

Of this species Verrill writes (Ext. and Int. Parasites, p. 28):

> The *Gastrophilus nasalis* is a smaller species, densely hairy, with the thorax yellowish red or rust-colored. The abdomen is either whitish at base, with the middle black and the apex yellowish brown and hairy; or the base is whitish and all the rest brown; or the middle is black, with the base and apex whitish, with grayish hairs. The wings are unspotted. The larvæ are much like those of the preceding [hæmorrhoidalis], except that they are smaller, and also live in the stomach of horses. They change to pupæ beneath the manure, and the flies appear from June to September. It also infests the ass and mule, and some authors say that it lives even in cattle.

Zurn[1] ascribes this parasite to horses, asses, mules, and goats, and says the eggs, 1 mm. long, are laid on the lips and margin of nostrils. He describes the full-grown larva as 13 to 14 mm. long, deep yellow or yellow brown, thicker behind than before, and the segments 2 to 9 above and 2 to 10 below with a single row of yellowish, brown-tipped spines.

The pupa he described as dark-brown or black, the segments with only a single series of horny spines, its length of life in this stage from thirty to forty-two days.

Professor Garman[2] in a recent paper on the subject gives a record of the occurrence of this species in Kentucky.

From this record it would appear that the species is somewhat common and troublesome in that region, and as the species has been recorded from many places in this country, it may be looked upon as having quite a general distribution.

The most essential point in habit of this species is the fact that the eggs are laid on the lips or nostrils, within easy reach of the tongue, and as it is quite probable that they hatch more promptly than those of *equi*, it is more difficult to adopt measures of prevention. Measures must consist in preventing as far as possible the deposition of eggs, for which purpose the application of a little tar and fish oil to the hairs of the under lip may be of service, and where eggs are suspected, the use of a wash of carbolic acid to the lips and margin of nostrils.

According to Garman, the eggs are white, and are attached to the hairs of the lip and throat by the greater part of one side. The species occurs in Europe and has been observed in New England, New York, Ohio, Kentucky, Kansas, Utah, and probably elsewhere in this country.

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[1] Die tierischen Parasiten, p. 100.

[2] The Bot Flies of the Horse, Seventh An. Rep. Ky. Ag. Exp. Sta., p. xxvii.

Professor Garman gives the following key by which the different species of bot-flies may be distinguished:

1. (6) Discoidal cell closed by cross vein.
2. (3) Wings marked with brown .... *G. equi.*
3. (2) Wings not marked with brown.
4. (5) Anterior basal cell nearly or quite equal to the discoidal cell in length. *G. nasalis.*
5. (4) Anterior basal cell markedly shorter than the discoidal cell. *G. hæmorrhoidalis.*
6. (1) Discoidal cell open.. *G. pecorum.*

Gastrophilus pecorum Fab.

We are not aware that this species has been encountered in the United States, and if so it is evidently rather rare. The following paragraph from Professor Verrill's report would seem to indicate an acquaintance with specimens collected in this country:

> The *Gastrophilus pecorum* is densely covered with yellow hairs, with a band of black hairs on the thorax behind the suture in the male. The female is yellowish brown, the abdomen black, with yellowish hairs at its base, as well as on the thorax. The wings are grayish or light brownish, clouded with yellowish brown. The larvæ are similar to those of the more common *G. equi*, and have similar habits. The flies appear at the same time.

Osten Sacken's list of American Diptera records it only from Jamaica on the authority of Walker.

THE BOT-FLIES OF CATTLE: WARBLE FLIES.

Until a few years ago it was assumed that the common bot-fly affecting cattle in this country was the same as the one most common in European countries, and the same specific name was applied to it with apparently little careful examination of either larvæ or adults to determine the question with certainty.

Following the announcement of Dr. Curtice, that the larvæ reached the backs of the animals through the œsophagus, a careful review of all available material was made (Riley, Insect Life, Vol. IV, p. 302), which indicated that the species most abundant, if not the only common form, was not the *bovis* of Europe, but *lineata*, which is likewise European in distribution.

There is so much in common, however, in the habits and nature of the injury of the two species that it seems appropriate to discuss some of these general features for the two species, and then to give the distinctive features for the two forms with reference to such differences of habit or treatment as may be necessary.

A considerable portion of this general matter was prepared prior to the discovery of the identity of our species with *lineata*, and, while written with *bovis* in mind, applies properly to the former species.

Historically, *bovis* has been recognized the longer, having doubtless been known from earliest times, and the larva often mentioned in writings from 1710 on as, possibly, also *lineata*, but *bovis* was described by DeGeer in 1776 under the name of *Œstrus bovis*, later changed by Latrielle to *Hypoderma bovis*.

In 1815 Bracy Clark, in his Essay on the Bots of Horses and Other Animals, presented probably the first careful study of its life history and habits, and later the researches of Brauer, Taschenberg, Zurn, and others have added to our knowledge of the species.

More recently Miss E. A. Ormerod, consulting entomologist of the Royal Agricultural Society of England, has published results of a number of reported and personal observations on its habits, injuries, etc., and during the summer of 1889 the Farmers' Review, in this country, undertook an investigation on much the same plan.

The species are, so far as we know, closely confined to the bovine race or nearly related species, *lineata* being regarded as a parasite of the buffalo as well as the ox. Kollar (Treatise on Insects) speaks of *bovis* as affecting besides cattle, the stag, roe, and camel, but no authentic record of such occurrence has been noted, and he may have had as a basis for the statement the related species occurring normally on these animals. There are, indeed, records of the rare occurrence of these parasites on man, but such are exceptional, and the species should be considered as restricted, primarily, to bovine animals. On account of this restriction, the insect is known in the larval stage only where cattle are kept, and can be introduced in a new country only in the larval stage with the animals. It is in this manner and this alone that they have been scattered over the world with domestic breeds of cattle.

EXTENT AND MANNER OF INJURY.

The losses from warble flies must be considered from three distinct points, only one of which can be estimated with any great accuracy. They are (1) the loss incurred on the hides perforated by the maggots, subjecting them to discount or rejection in the markets; (2) the loss in milk and beef supply caused by the fretting and stampeding due to the presence of the flies when laying eggs, and (3) the loss to the vitality of the animal, its weakened condition, and consequent loss in milk or beef due to the presence of the warbles, with accompanying ulcers in the back, sometimes, it is asserted, resulting in the death of the animal.

LOSS ON HIDES.

This will vary in different countries, both from the actual differences in abundance of warbles and consequent perforation of the hides and from the different rates of discount applied by different dealers. That it is by no means insignificant will appear from the following condensed statements of statistics and evidence on the subject:

As a result of many inquiries and testimony from numerous sources, Miss Ormerod estimated the loss in England at $5 per head for cattle.

The results obtained by the Farmers' Review in its recent investigation are summarized as follows (Insect Life, Vol. II, p. 157):

> From the reports received the approximate percentage of grubby cattle and the average loss on grubby hides for the principal stock-raising States of the Mississippi Valley have been estimated as follows (August 7, 1889):
>
> *Illinois.*—Seventy-three per cent of the cattle marketed in the grubby season are infested with grubs. The average loss on a grubby hide is one-third.
>
> *Iowa.*—Seventy-one per cent of the cattle in the majority of counties are grubby in the season specified. Loss on grubby hides one-third.
>
> *Indiana.*—Forty-eight per cent of the cattle grubby. Loss on hides one-third.
>
> *Wisconsin.*—Thirty-three per cent of cattle grubby. Loss on hides one-third.
>
> *Ohio.*—Fifty-six per cent of cattle grubby. Loss on hides one-third.
>
> *Missouri.*—Fifty-seven per cent of cattle grubby. Loss on hides one-third.
>
> *Kansas.*—Sixty per cent of cattle grubby. Loss on hides one-third.
>
> *Kentucky.*—Fifty-seven per cent of cattle grubby. Loss on hides one-third.
>
> In *Minnesota* and *Dakota* grubs are practically unknown among cattle.
>
> In *Nebraska* they are not very bad where found; twelve counties report an average of 40 per cent. The rest heard from are free of the pest. Grubby hides are "docked" one-third of their value.
>
> In *Michigan* 61 per cent of the cattle are infested with grubs in the southern and middle counties. In the northern counties they are unknown or very scarce. Grubby hides sell for one-third less than sound ones.

The amount of this loss can be better appreciated perhaps by reproducing in condensed form the approximate estimate of the loss on the hides of cattle received at the Union Stock Yards of Chicago during the grubby season, which includes the months from January to June. Using the reports by States above given as a basis it is estimated that 50 per cent of the cattle received are grubby. The average value of a hide is put at $3.90; and while from the report referred to one-third value is the usual deduction for grubby hides in this estimate, but $1 is deducted, or less than one-third. The number of cattle received in 1889 for the six months indicated was 1,335,026, giving a loss on the 50 per cent of grubby animals of $667,513. When to this is added the loss from depreciated value and lessened quantity of the beef, the amount for each infested animal is put at $5, indicating a total loss on these animals from the attack of the fly of $3,337,565.

LOSS IN MILK AND BEEF FROM ATTACK OF BOT-FLIES.

In trying to present any estimate of loss from this source we are confronted by the fact that many other flies with these serve as a constant source of annoyance to cattle in pasture, exciting them at times to a wild frenzy, when they go chasing about trying to avoid their enemies, and not only losing the opportunity to feed peaceably, but using up in useless activity the nutriment which should go to form milk or flesh; at other times driving them into ponds or streams of water or into the shade of trees or sheds, where they remain for hours at a time, only partially relieved from the torments of their foe and losing the opportunity for feeding which is essential to growth or production of milk. It is, of course, impossible to separate the losses due to each kind of fly, and even if it were possible it would be difficult to state in exact figures the sum lost. The following note, quoted by Miss Ormerod, is perhaps as good an illustration as we can select to show approximately this loss as estimated by a practical breeder and dairyman:

> We all know, to our cost, how greatly these irritating flies torment and madden the cattle, causing them to gallop or run as if for their lives to get away from the buzz and presence of their tormentors. Feeding cattle can not grow in flesh without quiet and rest, and milking cows must suffer to a greater extent than we are

aware of. To use a common remark, they soon "bate"—*i. e.*, give less milk. To drive a cow fast or cause her to be excited reduces the quantity and quality of the milk. Without perfect quiet and rest they can not do their best for us. This leads me to one important point. What is our loss in the cheese tub caused by the warble and gad flies? I have tried to estimate the loss during the four or five summer months or even the eight months that a cow is supposed to be in profit. There are certain times of unrest when the cow will give about half of her usual flow of milk. These tormenting flies and the presence of the prickly-coated warble maggot must keep up a perpetual uneasiness and retard the growth of our feeding cattle, to our loss, it may be, of £2 per head. In the dairy cows the loss will be greater. The daily loss of milk may make a difference of a hundredweight of cheese per cow per annum. Half a hundredweight, or 12 per cent of milk less in a dairy, making 4 hundredweight at 70 shillings, comes to 35 shillings. But 12 per cent is too low an estimate. It may in some cases be put at £3 per head, and in a dairy of 100 cows would show a loss of £300.

This source of injury, however, lasts but a few weeks during summer, and probably does not compare with the loss due to the presence of the maggots. This must be a constant source of irritation to the animal and a drain upon its energies from the time the warble begins to grow until the sore heals after the departure of the maggot. It extends through at least one-third of the year, while the whole period of invasion probably lasts for eight or nine months. Imagine some fifteen or twenty boils or carbuncles located along the back producing a regular supply of muco-purulent matter due to the inflammation and supplying nutriment to a healthy grub which grows to be three-fourths of an inch in length, and suppose, if possible, that these are no discomfort or cause of loss to the creature affected with them.

The occasional attacks of one or more species of bots upon man and the discomfort caused by them in such cases would seem to be sufficient proof of the irritation caused in the lower animals, even if we allow something on the ground that these lower animals are less sensitive to pain. Omitting, however, the creature's comfort as a matter of mere sentiment and considering the question from the practical standpoint of money returned, it requires only the very modest estimate of the loss of $1 per head to the cattle of the United States to show a loss of about $36,000,000 sustained by the country on the basis of the census of 1880 (doubtless between fifty and sixty millions at the present time). Young animals are injured more than old ones, and many writers assert that deaths are not infrequent from the effects of warbles.

Without considering the lessened quantity, the inferiority of the beef of animals infested by the grub is strikingly shown in an article on the subject in which the testimony of retail butchers and buyers of meat in Chicago and other cities is given. It is shown that the buyers of the highest class of meat, who supply hotels and restaurants, will not on any account purchase carcasses showing traces of warble attack. Such beef has to be sold, therefore, at a price below that obtainable for good beef, free from grub damage, and the lessened value per animal was put at from $2 to $5.

The appearance known as licked-beef, which, resulting from the presence of the grub, may be described as a moist or running surface of a greenish-yellow color, is certainly unwholesome in look, if not in fact. The description of such meat as given in the Farmers' Review, quoting again largely from Miss Ormerod, is almost sufficient to turn one against beef altogether.—(INSECT LIFE.)

If we take the estimates as a whole, some of which have been published since the first writing of this chapter, it is evidently a modest estimate to consider the losses from the different sources of injury to hides, loss in milk and beef, and lessened vitality to be $2.50 per head of cattle for the whole United States, making a grand total of $90,000,000 on the basis of the census of 1880. Were this loss something unavoidable or requiring the expenditure of much time or money to prevent, there might be some excuse for its continuance, but since it can by simple and inexpensive methods be not only wholly prevented from year to year, but practically exterminated from the country, thereby avoiding both the loss and the trouble of applying remedies in the future, it would seem of the greatest utility to adopt those necessary measures without further delay. The preventive measures necessary become at once apparent by knowledge of the life history and habits of the insect.

OCCURRENCE OF WARBLES IN MAN.

There are many instances of the occurrence of the warble in man, and these records contain instances which are to be referred to both of the species, Dr. Riley having positively identified one such case at least for *lineata*, and Dr. William Schoyen being authority for the European records of *bovis*. In all these cases there seems to have been a large amount of migration on the part of the larva and usually an emergence from the skin before complete maturity, which would suggest that the larva does not find the conditions exactly normal. The following instance observed by a physician who is also a trained entomologist is of special value as showing the conditions of such an occurrence:

> Several years ago I saw, professionally, a boy 6 years of age who had been suffering for some months from the glands on one side of his neck being swollen and a fetid ulceration around the back teeth of the lower jaw of the same side. Three months treatment was of no avail, and the end seemed near; one day a white object, which was seen to move, was observed in the ulcer at the root of the tongue, which on being carefully extracted proved to be a large grub, which, from having frequently seen them, I recognized as a full-grown larva of Hypoderma. It was of the usual tawny color, about half an inch long when contracted, about one-third that thickness, and quite lively. The case ended fatally. This boy had been on a farm in Illinois the previous fall, where probably the egg was in some way taken into his mouth, and the larva found between the base of the tongue and the jaw suitable tissue in which to develop, coming to maturity at the same time with those bred in cattle. (Dr. John Hamilton, in Entomological News, Vol. IV, p. 219.)

LIFE HISTORY AND HABITS.

In certain points of life history and habit the two species agree. The adult flies are about half an inch in length and bee-like in appearance, the two species separated easily by characters to be detailed later.

They appear during the summer months and deposit their eggs upon cattle, the act of oviposition being frequently accompanied by a great amount of annoyance to the animals, in some cases inspiring them with such terror as to result in costly stampedes, prevention of feeding, and nervousness that is very injurious to the animal.

The flies probably mate in the vicinity of their pupation, and the females seek the cattle in open pasture for the purpose of depositing their eggs. It is claimed by good observers that they will not fly over water or follow cattle when they seek protection in ponds or other bodies of water, and also that they do not enter sheds or trouble cattle in the shade. The method of deposition has been a subject of much discussion. The earlier writers asserted that the insect punctured the skin and laid the egg beneath, basing the assertion, it would seem, on the great terror and apparent pain of the animal when attacked and the position of the grub when first distinguishable. Réaumur even describes the boring apparatus by means of which it is able to pierce the tough hide of the ox. Clark and others, however, held with equal strength to the view that the eggs are simply deposited on the skin, and the larvæ begin at once upon hatching to burrow beneath. Williston (Stand. Nat. Hist., Vol. II, p. 427) says: "The eggs of Hypoderma are deposited on the hairs about the front shoulders, neck, and groins of artiodactyls only. It was thought for a long while that the female thrust the eggs within the skin, but such is now known not to be the case." Miss Ormerod, after careful study of the very young larvæ and course of their channels, says: "From the presence of these small cavities just below the cuticle, and the fine canal running downward from them or from the surface, as the case may be, to the young warble cell beneath the hide, I think we shall find that the egg is fixed just beneath the cuticle and that the young maggot works its way through the hide to where we find it in the early stage. It does not seem possible to me that the fly could pass the egg through the hide by means of her egg-laying apparatus (or ovipositor), because, as observed, the passage down the maggot cell is sometimes of a shape that could not have been caused by the ovipositor." It seems hard to believe that all the fright and apparent pain exhibited by the cattle is due simply to the alighting of the flies and deposition of the egg on the hair. They can not bite, for, as already stated, their mouth parts are rudimentary, and to suppose that the cattle are aware of the true nature of the pest and exhibit fear simply because of a knowledge that they will cause them future trouble is to accredit them with a wisdom rather beyond that usually granted to any of the lower animals. Neither does it seem that all this fright could be due simply to their resemblance to bees, for cattle are not so frequently stung by them as to develop such an intense fear of them.

> The structure of the ovipositor clearly excludes the possibility of puncture, for, though horny, it has a blunt, trifid tip, and is beset at the end with certain minute hairs, and structure of this character is a very safe guide to habit. (Riley.)

Until recently it was assumed as a matter of fact that the larvæ entered through the skin, but the discoveries of Dr. Curtice have proven, for *lineata* at least, that the normal course is by way of the mouth and alimentary canal, as will be discussed more fully under *lineata*. While from analogy it seems very probable that a similar habit will be proven for *bovis* I know no positive observations, but Miss Ormerod adheres to the belief that the entrance for that species is through the skin.

In either case the maggots, as a rule, must be within the animal as early as October (for *lineata* much earlier), and by January the lumps or swellings along the back denoting their presence become appreciable, and growth continues as late as April and possibly May, varying with latitude. We have quite fully developed specimens (of *lineata*) taken March 25, from the backs of cattle at Ames, Iowa, at which time they were mostly well grown and some of them apparently about ready to escape from the ulcer. After working their way through the opening in the hide, in which they are assisted by the prickly tubercles covering the body, they drop to the ground. The full process is thus described by Dr. Williston (Stand. Nat. Hist., pp. 427–428):

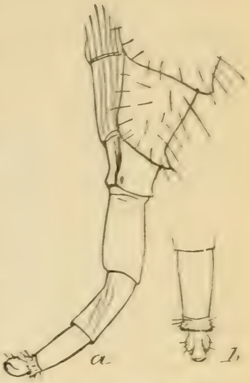

FIG. 38.—*Hypoderma lineata:* ovipositor of female: *a.* from side; *b.* tip, from below—enlarged (from Insect Life).

> They have the peculiar ability to contract either end into an elongate cylindrical form, which not only serves them in their egress, but also to bore into the ground. A few days before they are ready to emerge they begin to enlarge the opening by this expansion and contraction; when they have enlarged it sufficiently, a ring-like contraction of the body that begins at the posterior part and progresses toward the head enables them in a few minutes to free themselves, which they usually do in the morning hours. Upon the ground they creep about until they meet some obstruction, when they burrow from 1 to 2 inches below the surface, and remain as in the Gastrophilus species.

They remain in the ground as pupæ for about a month and then issue as flies.

REMEDIAL MEASURES.

Knowing that the insect occurs, during nearly three months of the year at least, in no other place than in the backs of cattle, it is evident that the destruction of all the grubs in the back of every animal between January and April must result in the extermination of the pest. That there are measures sufficient to accomplish this destruction is certain, and at an outlay of time and trouble that makes them practicable with every man who owns cattle, whether one or ten thousand.

Indeed the insect is open to attack in at least three different ways: (1) Measures to prevent the deposition of eggs; (2) measures to destroy the eggs or young grubs; (3) measures to destroy the grubs after passing under the hide.

To prevent the deposition of eggs the application of some persistent sticky substance may be recommended, or this may be combined with some substance of obnoxious smell.

Coating the back from neck to loins with tar or with a mixture of sulphur, 4 ounces; spirits of tar, 1 gill; train (whale) oil, 1 quart, once a week. Train oil alone two or three times in the season and one application of spirits of tar, carbolic acid, sulphur, and linseed oil combined, are reported in Miss Ormerod's pamphlet as effective for *bovis.*

Animals that are housed are said not to be attacked, and furnishing sheds in pastures or access to shade of trees or to bodies of water is considered as helpful.

We doubt, however, if these measures can be used as satisfactorily in large herds of cattle or on the ranches of the Western States as measures directed against the grubs. And unless the substance serves to catch and kill the fly it will of course simply seek animals not protected or possibly be driven to deposit eggs on some other part of the body.

In January the warbles become large enough to be detected by passing the hand along the back, and at this time a little kerosene rubbed into each one or the application of mercurial ointment will destroy the grub, which rests with the breathing pores directed toward the surface, securing its supply of air through the small channel connecting the cavity with the outer surface. The sore heals up and the hide in a short time becomes perfect, so no loss need be incurred if the animal is to be slaughtered in late winter or early spring, and for milch cows the drain upon their vitality and productiveness is stopped.

Even if these measures have been adopted every animal should be examined during March and any grubs found should be destroyed.

They are by this time quite conspicuous, being felt by running the hand along the back, or in many cases can be distinctly seen as prominent lumps. The hole through which they breathe and finally escape is now large enough, so that by careful pressure the maggot may be forced out unbroken. If necessary, the opening may be enlarged a little by using a round stick bluntly pointed, as a probe. If late in the spring, all grubs pressed out should be crushed to prevent possibility of their getting into suitable places to pupate and finally reach the adult stage. For cattle in stables it is a very simple matter, while handling or feeding them, to run the hand along the back, and on detection of a grub to press it out, and all farm hands should be instructed to lose no opportunity to relieve the cattle from these annoyances.

While it is certain that this insect could be practically exterminated in the United States in a single year, we realize fully the great difficulty in getting every person owning cattle to know or appreciate the need of using the necessary means; and two or three scrub cows in a county uncared for will of course perpetuate the species. Nevertheless, this should not debar anyone from attending to the matter with his own stock, for, since the flies travel but short distances, every farmer may secure practical immunity in his own herds, and after the first year's thorough work have scarcely any trouble in attending to them. He should, of course, examine carefully every animal brought to his farm, and rid it of grubs before the time of their maturity. Many farmers are careful to attend to this matter already, but there is no systematic attention to it, and the only permanent check to their increase at present lies in the fact that millions of them infesting cattle slaughtered between October and April perish with their hosts, and hence only those in cattle kept over from year to year survive to continue the species.

We can not close this sketch of remedies without presenting a plan which, though it may be styled fanciful or ideal, must if carried out result in the extermination of the pest and a saving, we believe, of not less and probably more than $50,000,000 per year to the farmers of the United States.

Let every man owning kine of any grade be posted by a general proclamation inserted in every newspaper in the land that in a certain winter, say 1900, he is to examine every animal in January and apply kerosene or mercurial ointment to all lumps discoverable on the back from the neck backward, and down halfway on the ribs; that in March or at latest before the middle of April he must go over every animal again, and press out and destroy any warbles remaining. Then the following winter if any warbles whatever are to be found to repeat the processes. This, with the destruction of grubs in all cattle imported from other countries, must prove successful. Even if a few escaped by the neglect of some shiftless stock owner, or by accidental oversight in searching for them, the result would repay over and over again, and for many years, the grand effort of that year.

Ox Bot-fly or Warble Fly.

(*Hypoderma bovis* DeG.)

As previously stated, this species was formerly supposed to be distributed over America, but the utter failure to find a single specimen of the larva or adult in the mass of material that has been examined in the last few years makes it doubtful if even the earlier records of its occurrence in this country can be relied upon, and therefore it seems necessary to define its distribution as covering the countries of the Old World surrounding the Mediterranean. Brauer gives its European distribution as from Scandinavia to the southernmost portions, and also says it is distributed over Asia, Africa, and North America.

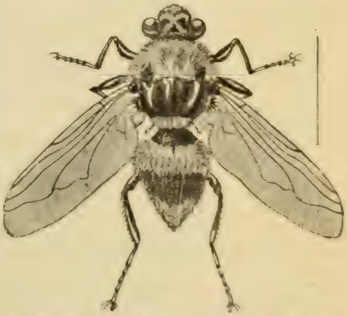

Fig. 39. — *Hypoderma bovis* — enlarged after Brauer).

The adult fly, shown enlarged in the accompanying figure, is half an inch or a little more in length and not very different in general appearance from a honeybee. It is quite hairy, and, although the surface of the body is black, except the front of the face below the eyes, the color of the hairs gives it a banded appearance, the face white, the front part of the thorax yellow, middle of the thorax black, hind part of the thorax whitish, base of abdomen whitish, middle of abdomen black, and apex of abdomen orange red.

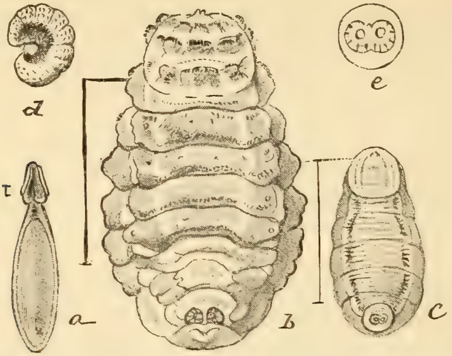

FIG. 40.—*Hypoderma bovis: a*, egg; *b*, full-grown larva, ventral view; *c*, puparium, ventral view; *d*, newly hatched larva, side view; *e*, anal stigmata of larva—all enlarged (after Brauer).

The eggs are elongate oval, with an appendage for attachment to the hair (fig. 40, *a*).

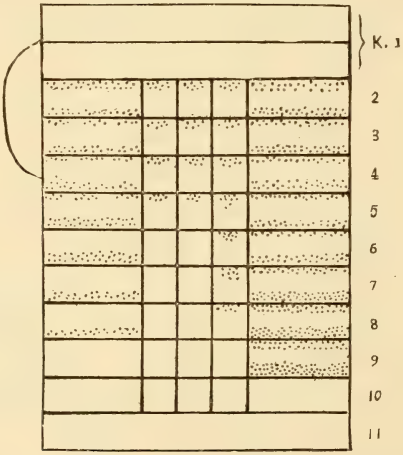

FIG. 41.—*Hypoderma bovis:* diagram of spiny armature (after Brauer, from Insect Life).

The larva of this species is only known in the later stages, that of the first stage not being described. Brauer describes the second and third stages, the latter form being carefully figured, and the figure is here reproduced from an illustration in Insect Life.

This larva is thick and fleshy, of a yellowish white color, becoming darker as it approaches maturity, but the most distinctive characters are found in the disposition of the spines which cover most of the surface of the body. The last two segments are entirely naked, and also the dorsal and lateral prominences of the ninth segment are free from spines.

This arrangement of spines is clearly shown in the diagram, which is a device adopted by Brauer to indicate the difference in spine distribution in the different species. Comparison of this figure with that for *lineata* will serve to determine at once the identity of a specimen. The wide spaces represent the dorsal (the left) and the ventral (the right) surface, and the narrow spaces the three rows of lateral protuberances. The spines on the upper and lower border of the segments are represented by dots.

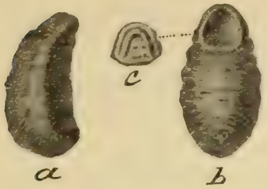

FIG. 42.—*Hypoderma bovis*: *a*, puparium, from side; *b*, same, from below, showing exit hole of adult; *c*, cap which splits off to allow the adult to issue—natural size (after Clark).

The pupa is an oval dark body formed from the contracted larva, the anterior end of which is removed when the imago issues. It is clearly illustrated in the annexed figure (fig. 42).

The treatment of the species is discussed under the general treatment for both species.

OX BOT-FLY OR HEEL FLY.

(*Hypoderma lineata* Villers.)

The synonomy and distribution of this species has been very fully discussed by Dr. Riley in Insect Life (Vol. IV, p. 302), along with a discussion of the distinctions of the species and I shall extract largely from this article as well as from the one by Dr. Curtice, (Journal Comparative Medicine and Veterinary Archives, Vol. XII, pp. 265–274, June, 1891).

The species was described in 1789 by Villers (Ent. Linn., Vol. III, p. 249), and later (from larva) by Brauer as *bonassi*.

Much confusion has existed, particularly because of the assumption that the common warble of this country should be referred to *bovis*, but the matter has been definitely set to rest by the researches detailed in the above-mentioned papers, which may be consulted for full details.

Aside from the occurrence in the buffalo, which appears to have been not uncommon, it is evidently a parasite normal to cattle. Which of these animals, if either of them, was the primary host of the species can not be stated, although the evidence seems to me to favor the opinion that it was primarily a parasite of the ox and that its occurrence on buffalo followed the introduction of cattle into this country.

In Europe it is said to occur in Switzerland, Norway, Crimea, the Balkans, the Caucasus, England, Lower and Upper Austria, etc., but it has not been noted in Styria or Hungary. In America it is known from all parts of the United States, but is especially abundant in the southern portion and extending north to Illinois, Iowa, and Nebraska.

The amount of terror inspired by the adults is sometimes very great, and the following graphic account of its attacks in Texas by a gentleman who has given much time to them will serve to show its manner of work and the loss entailed:

> I believe that here the fly invariably deposits its eggs on the hair around the heel, although the popular notion is that the fly actually stings the animal. The cattle lick themselves, thus conveying the eggs into the mouth, the larvæ making their way in between the walls of the gullet. Here they remain some months, when they finally make their way up to the skin along the back, where they bore through, remaining in the hole a little over two months. When they first reach the skin they are quite white, but gradually color and become a dark brown or black, and forcing themselves out of their sacks fall to the ground. The skin of the larva becomes dark and shell-like, and at the end of about six weeks the perfect fly emerges.
>
> Although I know that in Pennsylvania the backs of the cattle are often badly infested with these larvæ, showing that the fly is by no means rare, yet I never saw that its presence caused any fright or even uneasiness, while here it is so dreaded by the cattle as to cause at times heavy loss to stockmen. The time of the fly beginning and ending its attack is very variable. I have seen cattle running from it as early as December, while this year up to date (February 15) I have seen no indication of its presence.
>
> Cattle seem to become absolutely frantic from terror; a steer will be quietly grazing, when suddenly he will spring forward, head erect, tail arched, and in a moment he will be madly rushing across the pasture, probably to the creek, into which he will plunge, remaining for hours. If the streams running through the pasture have muddy bottoms many weak animals become mired and perish miserably unless discovered and pulled out. As the fly generally appears toward the close of winter, when cattle are often comparatively poor and weak, the loss in this way would be very serious but that stockmen have their men ride daily along the banks of any boggy streams in order to rescue mired animals.
>
> When a cowboy finds one unable to get out he uncoils his lariat, deftly thows it over the horns, gives a turn or two around the pommel of his saddle, and calling on his pony, the animal, unless very badly mired, is soon on the bank and in safety, and hereafter often comes the most difficult part of the business—the letting go. In getting hold the cowboy has it all his own way, but once the animal is on solid earth again it forgets its former peril, remembering only the terrible wrench to head and neck, and proceeds to get even with its tormentor, with the result that the man has sometimes to drop his rope and ride off trusting to its becoming loosened and dropping off. Can any one suggest the reason why the fly has such terrors for a Texas cow, whilst in Pennsylvania she cares nothing for it?—(George W. Holstein, in Entomological News, Vol. IV, p. 299.)

LIFE HISTORY.

The egg.—The egg, including the pedicel or clasping base, is 1 mm. long and 0.2 mm. wide at the greatest diameter. In color it is dull yellowish white, and the surface is smooth and shining. As may be seen by the illustrations (fig. 43, *a*, *b*, *c*, *d*, the egg consists of two distinct parts, viz., the egg proper and the clasping base, which firmly secures it to the hair and connects with the egg proper by a thin but rather wide pedicel. This base is made up of two lips or valves, which close over the hair and thus give a very secure attachment. The egg is narrow, ovoid, broadest at its middle, and larger at the base than at the tip, which is more or less abruptly and obliquely truncate (fig. 43*d*).

The striking results of the researches of Dr. Curtice, which showed that the larvæ are taken into the mouths of the animals and pass by way of the œsophagus to the subcutaneous tissue along the back, have already been mentioned, and it now remains to give in detail the stages of the larva during this strange career. The time occupied by the larva is sometimes quite long, occupying several months in reaching the skin, while the development after reaching this location is more rapid.

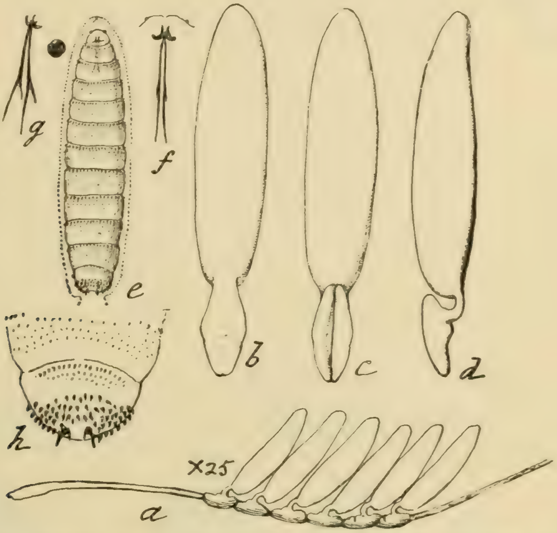

FIG. 43.—*Hypoderma lineata*: *a*, eggs attached to hair; *b*, *c*, *d*, dorsal, ventral, and lateral view of egg; *e*, embryonic or first larva, as seen in the egg; *f*, *g*, mouth-parts of same—enlarged; *h*, anal segments of same—still more enlarged (from Insect Life).

The larva, first stage.—This stage (fig. 43, *e*) when ready to leave the egg, or when first hatched, is 0.08 mm. long by 0.02 mm. in width, tapering above. Within the egg it fills the cavity and may be seen through the shell and quite readily removed. It is dull white in color, with the surface from the second to the twelfth joints distinctly and densely spinose. The armed area occupies the entire surface of these joints, except a narrow lateral free space. The arrangement of the spines on these joints, except the last, is uniform, with perhaps a slight increase in the size of the spines from the second to the eleventh joint. The armature of these joints and of the anterior half of the twelfth consists of a rather prominent and posteriorly directed row on the anterior margin of each joint, followed by numerous smaller prickles, which decrease in size and abundance toward the posterior margin of the joint. The posterior half of the terminal joint is armed with very much larger and slightly curved prickles or spines, which point posteriorly on one side and anteriorly on the other (see fig. 43, *h*). The anal spiracles are represented by dark circular spots, and terminate in two prominent spines. The anterior spiracles appear as two minute elevations, and the mouth parts consist of two dark crescent-shaped hooks, the upper extremity of which projects, and two long supporting rods which furcate basally, and on the tips of which the hooks articulate (fig. 43, *f*, *g*).

Second stage.—In the absence of any knowledge of an intermediate form, the larva found in the œsophagus may be considered as the second stage (fig. 44). The individuals vary in length from 11 to 14 mm. and are quite smooth and devoid of prickles, except some minute ones, which appear like black specks partly surrounding the anal spiracles (fig. 44, *d*) and a few extremely minute ones just above the mouth parts (fig. 44, *c*). The former, or those around the anal spiracles, are of peculiar structure, and consist of a circular, brownish-black, slightly elevated base, in the center of which arises a short, stout, posteriorly curved very minute spine, less than one-half the diameter of the base in length. The mouth parts are more prominent than in the first stage, and the apical portion is broadened and furcate near the base (fig. 44, *b*, *c*). This stage does not differ in any essential way from the stage first found under the skin in the back before the perforation to the surface is made. (See fig. 45, *a*, *b*, *c*.)

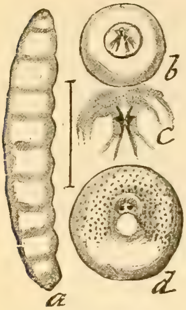

FIG. 44.—*Hypoderma lineata*: Second stage of larva from œsophagus; *a*, larva; *b*, enlargement of cephalic segments, end view; *c*, mouth-parts; *d*, enlarged end view of anal segment, showing spiracles and spines (from Insect Life).

Third stage.—In this stage, which is the second form of the larva found in the back (fig. 45, *d*, *e*, *f*), the larva again diverges markedly from the second or preceding stage and acquires many of the characteristics of the mature larva. It tapers, however, considerable toward the posterior extremity, rather than the reverse, and the spinous armature varies considerably in different specimens, but ventrally is similar to that of the adult, the spines being, however, more numerous and less prominent. The lateral armature is sometimes almost wanting, but occasionally occurs to the amount shown in the figure (fig. 45, *d*). The dorsal armature is much more scanty, and is either limited to the first and second joints or frequently entirely wanting.

Fourth stage.—The fourth and last larval stage is shown with characteristic armature at, fig. 45 *g*, *i*, dorsal and lateral views. Its chief difference from the larva of *bovis* (as shown in the diagram) is that the penultimate segment ventrally and also dorsally is spinose, as the preceding ones on the posterior margin, while in *bovis* it is distinctly unarmed. The full-grown larva when escaping from the back is of a grayish-white color and ranges in length from 22 to 25 mm.

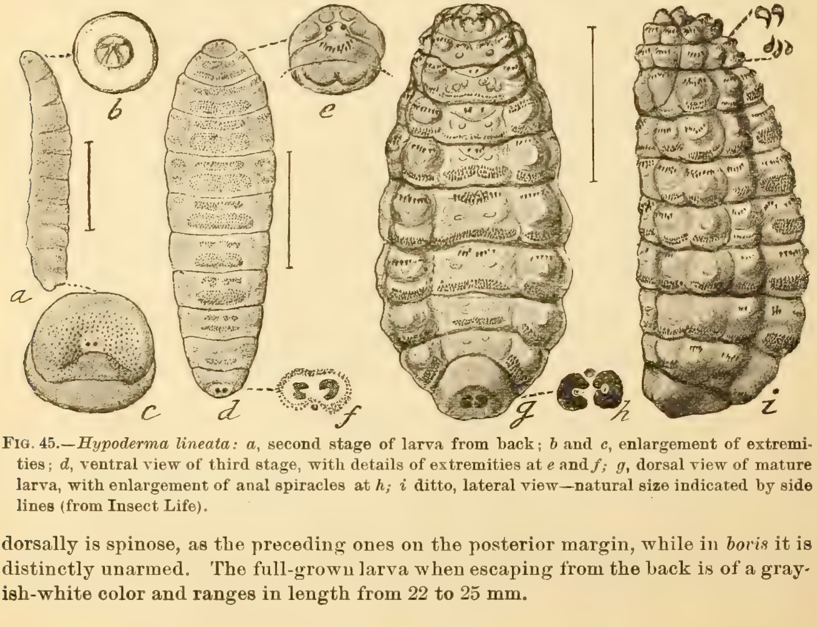

FIG. 45.—*Hypoderma lineata*: *a*, second stage of larva from back; *b* and *c*, enlargement of extremities; *d*, ventral view of third stage, with details of extremities at *e* and *f*; *g*, dorsal view of mature larva, with enlargement of anal spiracles at *h*; *i* ditto, lateral view—natural size indicated by side lines (from Insect Life).

Puparium.—Once out of the back the larva rapidly darkens and contracts, and the puparium, which is merely the contracted and hardened larva, becomes dark brown, almost black, but otherwise possesses all the characteristics of the larva.

Imago (Fig. 47).—Length, one-half inch (five-eighths with ovipositor extended); general color, black; body more or less clothed with yellowish-white, reddish, and brownish-black hairs. The front, sides, and back of the head, the sides of the thorax, a band across the base of the scutellum, and the basal segment of the abdomen are covered with long yellowish-white, almost white, hairs. The head above, central thoracic region, including prothorax and mesothorax, middle segments of the abdomen above, and legs, clothed with brownish-black hairs, which on the head and thorax are more or less intermixed with whitish hairs. The covering of hairs is shorter and scantier on the head and thorax, and the tip of the scutellum and following parts of the thorax, together with four prominent lines on the thorax, indicated in the drawing by the high light, are smooth and highly polished. The hairs of the terminal segments of the abdomen are reddish-orange, which color also predominates on the hind tibiæ.

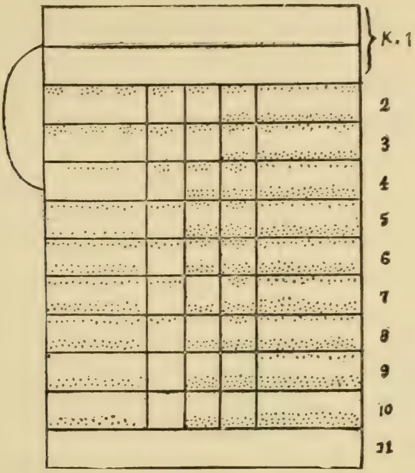

FIG. 46.—*Hypoderma lineata:* diagram of spiny armature.

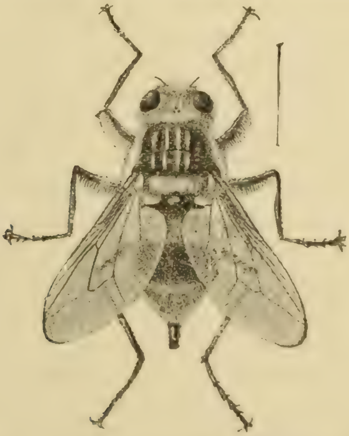

FIG. 47.—*Hypoderma lineata:* female—natural size indicated by side line (from Insect Life).

THE SHEEP BOT-FLY OR HEAD MAGGOT.[1]

(*Œstrus ovis* Linn.)

This insect, like the other members of the family, has been known for centuries, and has been equally dreaded by the animals it infests. It was mentioned by the Greek physician, Alexander Trallian, as far back as the year 560. Notwithstanding that it has been so well known, very different estimates have been placed upon the injury it may cause. Indeed, some writers have gone so far as to claim that no injury results from its presence, and to ridicule the idea that sheep die of "grub in the head." Even so high an authority as Mr. Youatt declares:

> It is incompatible with the wisdom and goodness that are everywhere evident, in proportion as the phenomena of nature are closely examined, that the destined residence of the *Œstrus ovis* should be productive of continued inconvenience or disease.

Mr. Randall is correct in saying that "this is as farfetched as a conclusion as the reasoning on which it is founded." If the grub in the head is not productive of inconvenience or disease, whence the suffering condition, the loss of appetite, the slow, weak gait, the frequent coughing, the purulent matter, sometimes so profusely secreted as at times to almost prevent the animals breathing? Whence the tossing and lowering of the head, and the fits of frenzy to which so naturally quiet and gentle an animal as the sheep is subject? All these symptoms result from grub in the head, and the animal frequently gets too weak to rise, and finally dies. These effects of the grub were well recognized and understood by such old writers and close observers as Réaumur and Kollar, while numerous flock masters of close observation who have suffered from this pest agree in ascribing these symptoms to this cause. It would be as reasonable to believe that those parasites are beneficial which are so injurious to man either internally or externally, or those which prey upon our caterpillars and other insects, and invariably destroy them. For although when there are but few grubs in the head the injury may not be perceptible, they can never be beneficial, and when numerous will undoubtedly cause death. They can not live in the head of the sheep without causing great irritation by the spines with which the ventral region is covered and the hooks with which they cling to such a sensitive membrane as that which lines the sinuses. Moreover, when numerous enough to absorb more mucus than the sheep secretes the grubs will feed on the membrane itself, and (according to the evidence of some practical sheepmen) will even enter the brain through the natural perforations of the ethmoid bone, through which pass the olfactory nerves, in either of which cases they must cause the most excruciating pain. The natural fear also which the sheep have of the fly and the pains they take to prevent its access to the nose are of themselves proof that it is obnoxious to them. The pest appears to have been more abundant in the Mississippi Valley than in the Eastern States, at times grubs being found in the head of almost every sheep that died. While it is possible that the disease produced by this insect may be confused with the "gid" or "staggers" produced by an entozoan parasite, the *Tænia cœnurus*, it is doubtless true that many cases of death from these bots are assigned to other causes. And, on the other hand, undoubtedly many other diseases are cloaked by the popular verdict of "grub in the head."

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[1] Adapted in part from Riley's Mo. Rep. I, pp. 161–165.

The flies which are represented in figure 48, 1 and 2, life size, make their appearance in June and July, and deposit living maggots in the nostrils of the sheep.

This point may be considered as well established by competent observers, although the older authorities all speak of the deposition of an egg. It may be possible, however, that eggs are deposited in cases where the flies are particularly fortunate in finding their victim without delay, but in such cases the eggs doubtless hatch almost immediately after deposition. The larvæ at once commence to work their way up the nostrils and nasal passages, causing great irritation on their way until they reach the frontal sinuses, cavities located between the two plates of the skull and lying one on each side of the central line of the head and between and a little above the eyes. There they attach themselves by the little hooks or tentacula, placed each side of the head, to the membranes which line the cavities, feeding on the mucus which is always to be found in them. Until they attain their growth they are of a creamy white color with two brown spots placed side by side on the posterior segment. These spots (fig. 48, 6, *c*) are spiracles or stigmata, through which the worm breathes. The segment with these two spiracles is retractile, and can be drawn in and hidden at the worm's pleasure. When full grown the grub becomes darker, particularly toward the tail, the white of the first two or three segments becoming dirty white on the fourth or fifth, and growing darker on each successive segment until the last, which is a very dark brown. (See 4 and 5 of fig. 48.) It has two small parallel hooks or tentacula at the head (*a*), and above these two very small tubercles, not very easily shown in the engraving. It also has small brown elevated round spots on each of the segments along the sides, which might at first be taken for spiracles, but which are not, and also two small corneous appendages (5, *b*, and 6, *c* of fig. 48) on each side of the anus. The ventral region has a band of small elevated

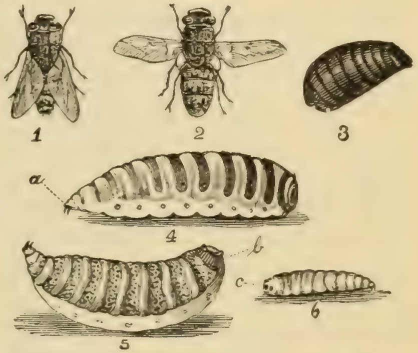

FIG. 48.—*Œstrus ovis*: 1 and 2. Adult fly. 3. Pupa. 4. Full-grown larva, dorsal view. 5. Same, ventral view. 6. Young larva. 1 and 2 natural size, the others enlarged (from Riley).

dots running the breadth of each segment in their middle, which, under the magnifier, appear to be minute brown spines all pointing posteriorly (fig. 48, 5). These aid the maggot in its movements. When ready to contract into a pupa it passes down the nasal passages of the sheep and falls to the ground, where it quickly buries itself, and in about forty-eight hours contracts to half its former size, and becomes smooth and hard and of a black color, tapering, as in the larvæ, toward the head. It remains in this state from forty to fifty days or more, according to the weather, when the fly pushes open a little round cap-piece at the head and thus arrives at maturity. In this stage it looks something like an overgrown house fly. The ground color of the upper part of the head and thorax is dull yellow, but they are so covered with little round spots and atoms (scarcely distinguishable without the aid of a magnifier) that they have a brown appearance. The abdomen consists of five rings, is velvety and variegated with dark brown and straw color. On the under side it is of the same color, but not variegated in the same way, there being a dark spot in the middle of each ring. The feet are brown, the under side of the head is puffed out and white. The antennæ are extremely small and spring from two lobes which are sunk into a cavity at the anterior and under part of the head. The eyes are purplish brown, and three small eyelets are distinctly visible on the top of the head. It has no mouth and can not, therefore, take any nourishment. The wings are transparent and extend beyond the body, and the winglets (calypteres), which are quite large and white, cover entirely the poisers. Its only instinct seems to be the continuation of its kind. It is quite lazy, and except when attempting to deposit its eggs its wings are seldom used.

PREVENTION AND REMEDY.

To prevent it from depositing its young, different means are resorted to. Mr. Randall says "some farmers turn up the soil in portions of pasture so that the sheep may thrust their noses into the soft ground on the approach of the fly, while others smear their noses with tar or cause them to do so themselves." But as the fly is very persevering, and generally attains her object, the means to be most depended on is the dislodging of the larvæ or grub, and so far lime has been thought the most effectual and should be given them so that by sniffing it they may be made to sneeze, and thus dislodge the grub in many cases. Some sheep keepers even shut their sheep up for several nights in a tight barn when first taken up in the fall, believing that the close and heated atmosphere induces the grub to descend, and is therefore more easily dislodged, and that the injury accruing from such foul air is trifling compared to the benefit received from dislodging the grubs. Other sheep breeders are in the habit of fixing salt logs in their pastures, of sufficient length to enable all the sheep to get at them. Into these logs, at intervals of 5 or 6 inches, holes are bored with a 2-inch auger, and during the season a little salt is kept in these holes, while every few days a little tar is smeared around them with a brush. The sheep in obtaining the salt tar their noses and the odor of the tar keeps the fly away. In severe cases, where the grubs are already in the head, they may be dislodged in a measure by a feather dipped in turpentine, which should be run up the nose and quickly turned. This, of course, can be but partially effective, as it is difficult to reach the extremity of the tortuous canals, and it is in such localities that they must cause greatest difficulties. For the same reason and on account of the great pain caused the animal the use of a wire to remove the larvæ as recommended by some should be discountenanced entirely. The burning of sulphur or other destructive substances in a closed room is likely to kill the sheep before reaching the larvæ in their retreats. In would be interesting, however, to determine what effect pyrethrum would have upon them. Valuable animals may be treated by trephining, to remove the grubs from the sinuses—an operation that should be performed by a veterinarian or skilled operator.

THE REINDEER BOT.

(*Œdemagena tarandi* Linn.)

This species is recorded as a parasite of the reindeer in Europe and North America and is doubtless of no little economic importance where this animal is an essential domestic species. Its habits are similar to those of Hypoderma, and it is recorded that the presence of the parasites is a source of great annoyance to their hosts. No observations have been made, so far as I know, to determine the manner of introduction, but there would seem to be the same probability of their introduction by the mouth as exists for the species of Hypoderma.

DEER BOTS.

Species of bots are recorded from deer, elk, and antelopes, the flies being included in the genus Cephenomyia. Two species of this genus are credited to America, but it is probable that careful collecting from these animals would increase the number.

THE EMASCULATING BOT-FLY.

(*Cuterebra emasculator* Fitch.)

In the supplement to his third report as State entomologist of New York Dr. Fitch presents the history of a bot-fly which is of remarkable interest, and though it does not affect any domesticated animal (except as squirrels may be kept as pets), the subject is of such interest that we can not pass it unnoticed in this connection. It would be interesting to reproduce Dr. Fitch's notes entire, but they are too lengthy for anything but a brief synopsis.

He reared the fly from which his description is made from a larva obtained from the striped squirrel or chipmunk (*Tamias striatus lysteri*). The larva occurred in the scrotum, causing it to become unnaturally enlarged, and when found lay with tail end next a small opening "larger than the head of a large pin, the testicles being entirely consumed." This larva buried itself August 13, 1856, and issued as fly July 29, 1857. So far as we know, this is the only adult of the species which has ever been reared.

Some notes upon the species were published by Riley and Howard in Insect Life (Vol. I, p. 214), with figures of the larva, a few paragraphs of which we reproduce here, with the figures.

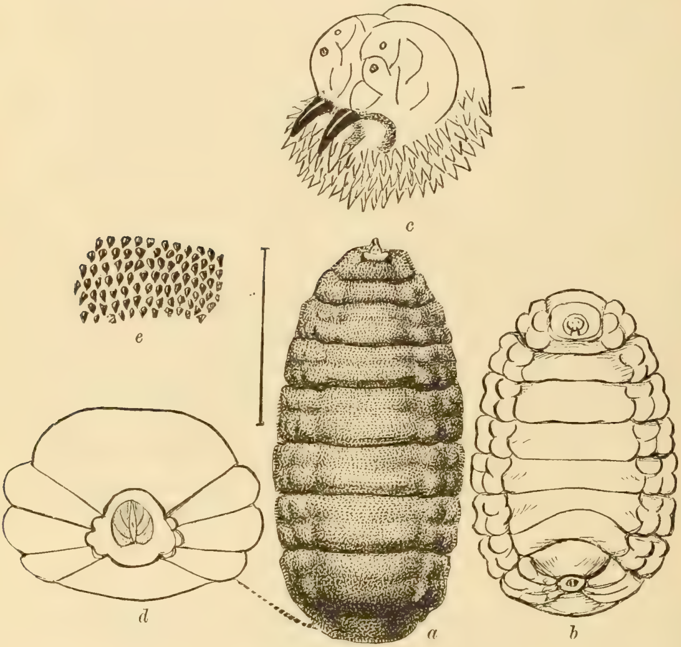

FIG. 49.—*Cuterebra emasculator:* *a*, full-grown larva from above; *b*, same, from below—enlarged; *c*, head of same; *d*, anal end of same; *e*, portion of integument of same—still more enlarged (from Insect Life).

Dr. Fitch published a painstaking description of the different stages and gave the species the name of *Cuterebra emasculator* from the larval habit which he supposed characteristic. He mentions the fact that hunters in the vicinity of Lakeville, N. Y., where the first specimen sent him was found, had long been familiar with the fact that at least one-half of the male gray squirrels shot in that vicinity were found to be castrated, and that it was the opinion of hunters that the deformity was caused by the squirrels seizing and biting out the testicles of their comrades. In support of this idea he gives the testimony of Mr. Hurst, taxidermist of the New York State Cabinet of Natural History, who claimed to have seen a half dozen red squirrels unite in mastering a gray one and castrating him. Dr. Fitch queries whether the bot-fly may not be attracted by the wounds so made, if this habit prove common, but concludes that the object of the joint attack of several upon one is rather to kill the grub which is engaged in emasculating him.

Unfortunately there is yet some doubt as to whether Fitch's species will hold. Brauer, in his Monograph of the Œstridæ, page 232, quotes Fitch's description at length, and states that he can not separate the species from *Cuterebra scutellaris* Loew, a North American species, the habits of which do not seem to be known.

If this interesting insect has not attracted much attention of late years from entomologists, it has not failed to be noticed by zoologists and taxidermists, although we are not aware that observations have been published. The following statement was written at our request by Dr. Merriam, the ornithologist of the Department, as we had learned by conversation that he had made notes some years ago on the abundance of the insect in New York State:

"In reply to your inquiry concerning the occurrence of Cuterebræ in squirrels, I would state that during many years collecting in the Adirondack region of northern New York, particularly along its western border, in the Black River Valley, I frequently found Cuterebræ in or near the scrotum in the gray squirrel (*Sciurus carolinensis leucotis*), red squirrel (*Sciurus hudsonius*), and chipmunk (*Tamias striatus lysteri*). I have observed the same thing at East Hampton, Mass., and in other localities. The most extraordinary instance of the prevalence of this disgusting parasite that has fallen under my observation was at the south end of Lake Champlain, New York, in October, 1885. On the 7th and 9th of that month I killed more than fifty chipmunks (*Tamias striatus lysteri*) within a few miles of old Fort Ticonderoga and on the rocky side hill behind the town of Whitehall. Of these a very large percentage—I think fully one-half—were infested with "wabbles" (Cuterebræ). More females than males were thus afflicted. The "wabbles" were usually situated near the median line, and anywhere from the umbilical region to the genitals. In a few cases they were in the axilla, and in one or two instances in the upper part of the foreleg. In a number of individuals two Cuterebræ were found and in a few cases as many as three.

"Dr. A. K. Fisher tells me that he collected a number of chipmunks about the south end of Lake George, Warren County, N. Y., during the latter part of August and first of September, 1882, a considerable proportion of which were infested with Cuterebræ. As many as three were found, in different stages of development, in one animal. A gray squirrel killed at Sing Sing, Westchester County, N. Y., contained a Cuterebra in the left pectoral region."

It is very possible that the larvæ of more than one species of the genus Cuterebra were concerned in the cases noticed by Drs. Merriam and Fisher, but this point can not be decided at the present time. * * *

Concerning the capture of the specimen, which was from a female chipmunk, Mr. Starkweather wrote, October 19, 1888:

"About noon on the 13th my children's pet kitten came in from the grove near our house, in the Rock Creek region, with a 'chippy' in its mouth. They rescued it at once, but, although warm, life was extinct. The strange appendage, or abnormal growth which they noticed on the under side, caused them to lay it away carefully in an empty covered cigar box 'to show papa.'

"My attention was called to it twenty-four hours later, when the dark-colored maggot was found in one corner of the box nearly motionless. They described the 'swelling' as about an inch long and of the shape of a mulberry. There seemed to be a natural opening at its apex over a sixteenth of an inch in diameter with a tinge of a dark liquid about it."

Subsequent inquiry has revealed the fact that squirrel hunters in this vicinity report that these grubs are very abundant around Washington in the common gray squirrel, one gentleman, with that freedom from fact-bias characteristic of the amateur hunter, stating that he never shot a squirrel which was not infested by grubs. We will doubtless, therefore, have opportunities for rearing the adult and comparing it with Loew's *scutellaris*.

The larva has already been well described by Fitch, and our figures will illustrate its appearance. The specimen from which they were drawn was evidently full-grown, and has entered the earth in a breeding jar.

It will be noted that all the cases so far cited show the larvæ to be mature in the latter part of summer or in fall, and in the specimen reared by Dr. Fitch pupation lasted through the winter and until the following July, which is quite different from the period of pupation in most of the bot-flies, ordinarily the pupa stage lasting but a few weeks and the winter being passed in the larval stage in the bodies of the host animal. It is hardly to be supposed that eggs laid by an adult the last of July could mature by the middle of August, so we must infer more than one year as necessary to the life cycle of the insect, in some cases at least.

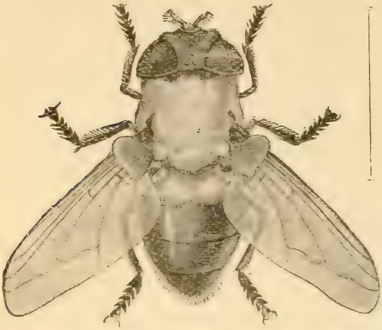

FIG. 50.—*Cuterebra cuniculi*: adult: side line shows natural length (original).

July 31, 1885, Mr. George K. Cherrie, then a student in the Iowa Agricultural College, took two larvæ from the scrotum of a chipmunk, the testicles being entirely consumed. These he placed in alcohol, and the specimens now in hand correspond perfectly with the description of larva given by Dr. Fitch, except that Dr. Fitch states that the head end presents no appearance of jaws or other appendages, while in these specimens the hook-like appendages are distinct. These might be so retracted, however, as to be inconspicuous and easily overlooked.

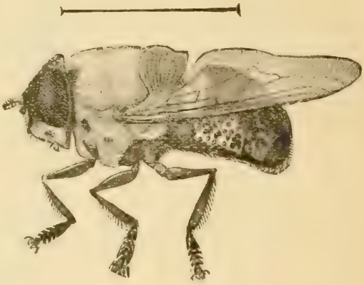

FIG. 51.—*Cuterebra cuniculi:* side view (original).

The figures here presented (fig. 49) were drawn from specimens received through the kindness of Mr. George B. Starkweather. The details concerning their capture, etc., we reproduce (see p. 107) from Insect Life (Vol. II, p. 216).

If it is allowable to detail a life cycle from the records at hand it would seem that full-grown larvæ are found from the 1st of August until in October, and that within this time, probably, they escape from the host and burrow in the earth to pupate, remaining in the pupa stage until July of the following year, eggs then deposited requiring at least one full year for the growth of the larvæ, and the life cycle being completed in not less than two full years.

THE RABBIT BOT-FLY.

(*Cuterebra cuniculi* Clark.)

Rabbits are infested with a very large bot, which attracted attention a century ago, the fly being named *Œstrus cuniculi* by Clark, and later, in the Essay, 1815, referred to the genus *Cuterebra*. while at the same time he described another form as *horripilum*. The adults of these two forms are so nearly alike that Brauer believes them to be the same, the *cuniculi* being described from a slightly denuded specimen. Without attempting to settle this question, we may proceed on the supposition that there is but one species and then call attention to the specimens which have exact correspondence with the description of *horripilum*.

The adult is a large fly, almost as large and having some resemblance to a bumblebee. The head is black, the thorax above covered with a yellow-brown hair, the first segment of the abdomen with yellow hair, and the rest of the abdomen of a blue-black color.

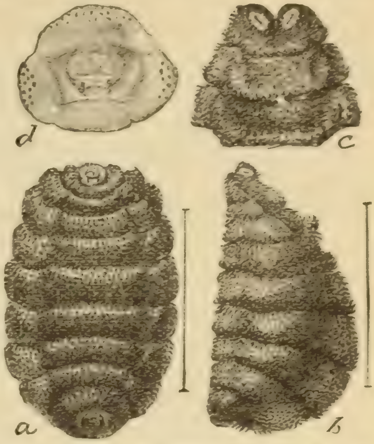

Fig. 52.—*Cuterebra cuniculi*: *a*, larva, ventral aspect; *b*, pupa, lateral view; *c*, anterior extremity; *d*, hooks and anterior spiracles of larva—all enlarged (original).

The egg and early stages of larva are unknown. but the full-grown larva is a large. black, spiny creature, found under the skin of the rabbit, where it forms a large tumor.

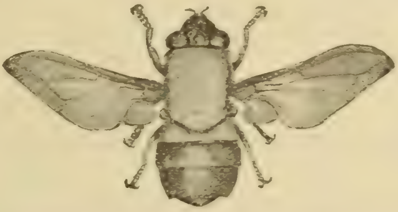

Fig. 53.—*Cuterebra horripilum*: adult—natural size (original).

The Department records show these larvæ to have been collected at Oracle and Florence, Arizona; Tuscola, Fla.; Savannah, Ga.; Riverside, Cal., and Estes Park, Colo., while specimens from St. George, Fla., referred doubtfully to this species, were taken from the necks of rats.

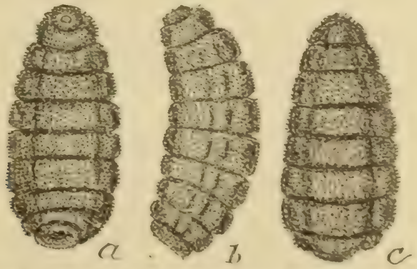

Fig. 54.—*Cuterebra* larva, collected at Ames: *a*, ventral; *b*, lateral; *c*, dorsal aspect (original).

In the accompanying figures, 50 and 51, from specimens belonging to the National Museum, the adult is shown in dorsal and side view, while figure 53 represents a specimen captured at Ames, Iowa, and which agrees perfectly with the form described as *horripilum.* The points of difference will be noted as pertaining to the fullness of the head in front of the eyes and in the form of the abdomen.

The larva shown in figure 52 is from a partially contracted specimen, which probably accounts for the difference between them and the fuller specimens shown in figure 54. The latter figures are from specimens collected by Mr. George K. Cherrie from the common rabbit at Ames, Iowa.

While the material at hand so far favors the belief that we have here but one species, it is desirable that a larger number of both larvæ and adults should be examined, and especially that more specimens be bred in order to establish beyond doubt the connection between certain forms of larvæ and the adults.

THE COTTON-TAIL BOT.

(*Cuterebra fontinella* Clark.)

This species was originally described by Clark from specimens taken in Illinois, but it remained practically unknown until the descriptions by Townsend in Insect Life (Vol. V, pp. 317–320). It is a large species, the flies being four-fifths of an inch and larvæ an inch in length. (See the full description by Townsend already noted.)

OTHER SPECIES.

Cuterebra buccata Fab. is another species that has been recorded at various times in this country (Kentucky, Pennsylvania, Carolina, Massachusetts, Washington, D. C.) and is doubtless a fairly common parasite of squirrels and possibly other small mammals.

Aside from these that have been mentioned there are a number of species in the genus Cuterebra from America which are known only in the adult stage, and to discuss them here would not only too greatly extend the paper, but would be of little value, since for monographic purposes the student will naturally refer to the works of Clark and Brauer.

BOT-FLY OF MAN, MONKEYS, DOGS, ETC.

(*Œstrus hominis* L.)

The question whether there is a bot-fly peculiar to the human species has been much discussed, but the burden of evidence at present available leads to the view that the species occasionally infesting man occurs also on dogs, monkeys, etc., and we therefore consider the species under the above heading.

The first record that can be considered as referring to this form is the description of Linnæus, Systema Natura, and which in Turton's translation, 1802 (Vol. III, p. 583), reads as follows:

> *Hominis.*—Body entirely brown
>
> Inhabits South America. Linné ap. Pall. Nord. Beytr., p. 157. Deposits its eggs under the skin on the bellies of the natives; the larva, if disturbed, penetrates deeper and produces an ulcer, which frequently becomes fatal.

Subsequent authors failed to verify Linnæus's account and concluded it was a myth, though Clark (Rees, Cyclopædia, article Bots), while considering it probably a spurious species, attempts to account for the record by saying that it is "perhaps merely an accidental deposit of *Œstrus bovis* in the human body, of which there are numerous instances."

Fabricius ignored it entirely in the Systema Antliatorum, and Latreille considers that the larvæ referred to were those of *Musca carnaria* or some analagous species.

Say, however, in 1822 described specimens which he had received from South America, and gives quite a detailed account of the habits as detailed by Dr. Harlan, who sent the specimens. (Jour. Acad. Nat. Sci. Phil., Vol. II, pp. 353–360; Complete Writings, Vol. II, pp. 32–38.)

To the account published in Say's Writings Dr. LeConte adds a description of his own experience with the insect and states that it is supposed to be the *Dermatobia noxialis* of Goudot.

Previous to this Keferstein (Über *Œstrus hominis*, Verh. Zool.-Botan. Gessells. in Wien, 1856, p. 637) had collected all the known facts regarding the bots infesting the human body, and Coquerel in 1859 had described larvæ taken from the human body in Cayenne, Mexico, and New Orleans (Revue et Magas. Zool., sér. 1859, T. 11, pp. 356–361), and with Sallé (361-367) and Laboulbène in 1861 a similar larva from Cayenne. Other authors mentioning it are Hill (N. T.), account of the larva of a supposed *Œstrus hominis* or gad-fly, which deposits its eggs in the bodies of the human species (Edinb. new Phil. Jour., 1830, pp. 284–288; Isis, p. 917, 1832), and Goudot (Observations sur un diptère exotique dont la larve nuit aux bœufs. *Cuterebra noxialis.* Ann. Sci. Nat., ser. 3, 1845, T. 3, pp. 221-230. Extr. Ann. Soc. Ent. Fr., ser. 2, 1844, T. 2, Bull., pp. 40–42.)

Brief mention is made of this species in the American Entomologist (Vol. I, p. 86) under the name of *Œstrus hominis* Gmelin, and in Packard's Guide (p. 406) occurs the following condensed paragraph on the subject accompanied by figures:

> The genus Dermatobia includes the *Ver macaque*, of Cayenne and Mexico, found beneath the skin of man in tropical America, and it is disputed whether it be a true indigenous "*Œstrus hominis*" or originally attacks the monkey, dog, or other animal. In Cayenne the species attacking man is called the *Ver Macaque:* in Brazil, (*Para*) *Ura;* in Costa Rica, *Torcel:* in New Grenada, *Gusano peludo* or *Muche.* The *D. noxialis* Goudot? *Ver moyocuil* lives on the dog and is found in Mexico and New Grenada. The larvæ are long, cylindrical, S-shaped, differing greatly from others of this family in form. The flies are closely allied to those of the preceding genus.

Professor Verrill (Ext. and Int. Parasites Dom. Animals, p. 24) mentions *Dermatobia noxialis* as laying eggs in the backs of sheep and cattle, and that "it also attacks men in the same way, forming painful tumors beneath the skin. The same or a similar species also affects the dogs in tropical America."

In a note appended to Professor Verrill's report there is a record of the occurrence of what is conjectured to be larvæ of the same insect, taken from a young woman in Mississippi.

And, quite recently, in an interesting article by Dr. Matas, published in Insect Life (Vol. I, pp. 76 and 80), we have an account of the extraction of three parasites from a man who was oviposited in while bathing during a trip in Spanish Honduras. The account agrees in all particulars with previous accounts of infection from this pest and emphasizes the fact of its injurious nature.

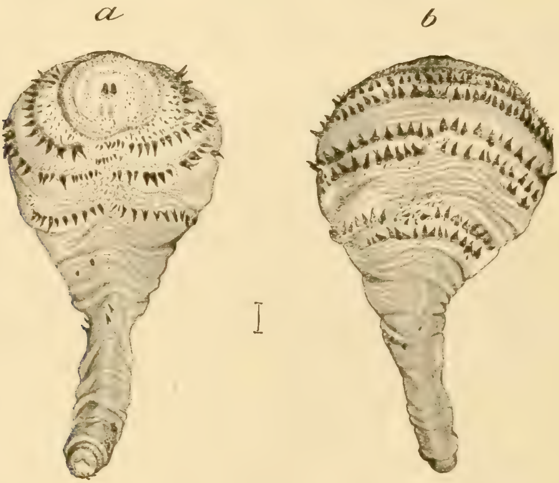

FIG. 55.—*Dermatobia noxialis:* larva; *a*, ventral aspect and appearance of cephalic and caudal extremities, also the three rows of spines, single below, and the point where the double dorsal rows end; *b*, dorsal view shows that the three rows of spines single below are double above—greatly enlarged (from Insect Life.)

We do not wish to attempt here a solution of the mixed synonomy of this species, or make any dogmatic assertions as to the accounts, all referring to one and the same insect. That should be demonstrated by the rearing of flies in the region where bots abound. It may be said in passing, however, that when occurring in man the larva must in the great majority of cases be killed before maturing, and hence the multiplication of the species be accomplished by the infection of some of the lower animals.

Treating the accounts in a body, there is certainly no doubt as to the injurious nature of the pest, for, while most reports are devoted naturally to presenting its injuries to man as of greatest interest, enough is said to prove that dogs and other animals are greatly troubled by them.

Upon man, all accounts, except that of Dr. LeConte, represent them as serious annoyances and some of them as fatal. Dr. LeConte says in the infested natives they seemed to produce but little uneasiness, and that the parties were not aware of the time when the eggs were deposited. He admits that "they produce a swelling having the appearance of an ordinary boil, in which at times is felt for a few seconds an acute pain when the worm moves."

Apparently no one has as yet obtained the adult fly from larvæ infesting man, either by rearing them from larvæ extracted or escaping from beneath the skin or by capturing them when depositing eggs. Linnæus's description refers to the larva.

In many accounts there is no reference to a distinct sting at the time of egg deposition, this being determined by subsequent location and development of tumors; but Dr. LeConte, already cited, remarks especially upon the victims not being aware when the eggs were laid, and this might give color to the existence of more than one species.

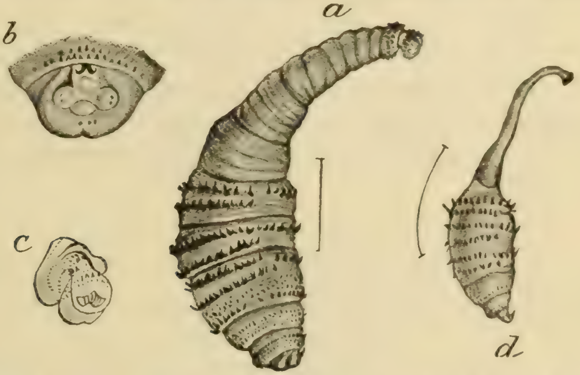

FIG. 56.—*a*, Brauer's figure of entire Dermatobia larva, supposed to be closely allied to specimens shown in fig. 55; *b*, cephalic extremity; *c*, caudal extremity of same specimen; *d* Dermatobia larva figured by Coquerel, and closely related to, if not identical with, preceding only seen under lower power and perhaps in earlier period of development—enlarged (from Insect Life).

It appears quite certain that in some cases at least the eggs are so fastened to the skin that the deposition is attended with pain.

The larvæ evidently hatch very soon after and develop with considerable rapidity, but since in all recorded cases the larva has been extracted before maturity nothing is known of its pupation. The form is quite peculiar and renders the accounts at least all referable to one genus of Œstridæ.

We reproduce from Insect Life the figures presented in the paper by Dr. Matas.

The usual remedy consists in the forcible expulsion of the larva, sometimes assisted by incisions, the application of tobacco ashes, etc.

In a recent paper Blanchard[1] gives an extended account of the

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[1] R. Blanchard, Sur les Œstrides américaines dont la larve vit dans la peau de l'homme. Annales de la Société entomol. de France, Vol. LXI, p. 109, 1892.

species affecting man, and refers to two species, *Dermatobia noxialis* and *D. cyaniventris*, the species common throughout tropical America. In the former the second and third segments are provided with fine spines, while in the latter these segments are smooth; and in the former, also, the posterior border of segments 4 to 7 are without a range of hooks dorsally, while *cyaniventris* has these segments and also the eighth, sometimes, with a row of crooked hooks pointing forward on the posterior border dorsally.

Railliet speaks of these bots as at times a veritable scourge to cattle, aside from their attacks on man and dogs.

Family MUSCIDÆ.

(House Flies and Allies.)

These are robust-bodied, usually hairy flies, the larvæ of which are fleshy, footless maggots, living in decaying matter, ordure, etc.

THE HORN FLY.

(*Hæmatobia serrata* Rob.-Desv.)

In the introduction and rapid spread of this insect we have an excellent illustration of the importance of giving attention to the injurious insects of other countries and of taking all possible means to prevent their importation.

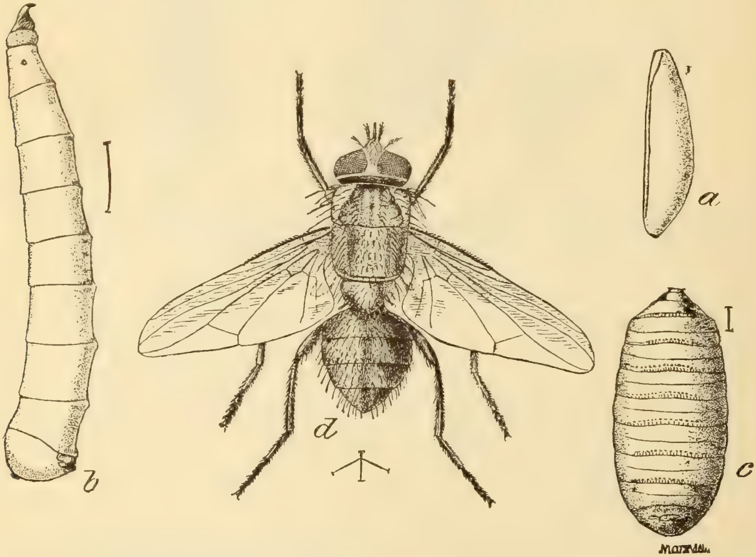

FIG. 57.—*Hæmatobia serrata*: *a*, egg; *b*, larva; *c*, puparium; *d*, adult in biting position—all enlarged (from Riley and Howard).

The species in hand has been a common insect in Europe, and with other members of the same genus recognized as a troublesome insect, though apparently no careful study of its life history has been made there.

It was first noticed as troublesome to cattle in this country in 1887, and while we can not say with certainty just when it was introduced we may be pretty sure that it was during the year 1886, or at most not earlier than 1885. It is even possible that it may have been brought over in the spring of 1887, as its powers of reproduction are such that a few weeks would suffice to make it a conspicuous pest in a limited area.

Within two years from the time when it was first recognized in serious numbers it had become so numerous and had spread over so large a region that it was made the subject of a very careful and successful study by Messrs. Howard and Marlatt of the Division of Entomology. The results of these investigations were published in Insect Life (Vol. II, p. 93) and in the Annual Report of the Commissioner of Agriculture for 1889.

It was also made a subject of study at the New Jersey Experiment Station, and Professor Smith's report in Bulletin 62 of that station gives the results of the season's observations and trials of remedies. Since these papers appeared the insect has spread over practically all of the United States east of the Rocky Mountains, and also into a large portion of Canada, and numerous articles have appeared in the bulletins of experiment stations and in agricultural journals with reference to it, the greater portion of them being based on the original studies above mentioned.

INTRODUCTION AND SPREAD IN AMERICA.

All accounts agree in placing the first serious occurrence of this insect in the vicinity of Philadelphia, and it appears probable that it was at that port that the flies first landed.

From there as a center it spread in all directions, though at first mainly southward, and by 1889 it had covered most of the State of New Jersey, portions of eastern Pennsylvania, a considerable area in Maryland, and also a portion of northern Virginia.

In 1891 it had been reported from New York, Ohio, Kentucky, Georgia, Florida, and Mississippi, and in 1892 from Connecticut, Massachusetts, Canada, Michigan, Indiana, Iowa, Louisiana, and Texas.

More recent records refer more particularly to its increase and local distribution in the various States, but it may be said to occupy now practically all of the United States east of the Rocky Mountains and the Provinces of Ontario and Quebec in Canada.

NATURE AND EXTENT OF INJURY.

As with most new pests, the nature and amount of damage caused by the insect was the subject of much exaggeration and wild speculation. As usual in such cases extreme views were taken, both of which were erroneous. Those who asserted that no damage whatever resulted from its presence were soon proven to be wide of the truth, while the exaggerated tales of death to animals, the destruction of horns, and many other wild statements were easily recognized as imaginative.

That the loss from their presence is very considerable is recognized by most practical stock breeders who have everyday association with the affected animals, the loss showing in reduced vitality, lack of growth, or in loss of milk.

Mr Fletcher, the entomologist of the Dominion of Canada, estimated the loss in Ontario and Quebec at one-half the product.

The loss is the direct result of the irritation to cattle, which keeps them in a perpetual worry and interferes with their feeding and with the normal digestion of food, and to some extent from the loss of blood, which, when the flies occur by the thousands on a single animal, is an item not to be ignored. When at rest upon the horns, at which time they are most conspicuous, they are in reality the least harmful, as they then cause neither irritation nor loss of blood.

The larvæ are of course entirely harmless and it is only the adults that affect the animals.

Injury to other animals than cattle seems to be very slight, and while a number of records have been given of the insect occurring upon horses these seem to be exceptional.

POPULAR NAMES AND POPULAR ERRORS.

Upon this subject Riley and Howard say:

> The popular name which is here adopted—the "horn-fly"—has the sanction of popular use. It is sufficiently distinctive, and we therefore recommend its adoption. The name of "Texas fly" and "buffalo-fly" and "buffalo-gnat" are also in use in some sections and indicate an impression that the insect came from the West. Dr. Lintner uses the term "cow-horn fly." Objections may be urged to all of these.
>
> The most prominent of the popular errors is the belief that the fly damages the horn, eats into its substance, causes it to rot, and even lays eggs in it which hatch into maggots and may penetrate to the brain. There is no foundation for these beliefs. As we shall show later, the flies congregate on the bases of the horns only to rest where they are not liable to be disturbed. While they are there they are always found in the characteristic resting position, as shown in fig. 60, and described later. Where they have been clustering thickly on the horns, the latter become "flyspecked" and appear at a little distance as though they might be damaged, and it is doubtless this fact which has given rise to the erroneous opinions cited.

HABITS AND LIFE HISTORY.

The adults of the horn-fly are about half as large as the common house fly and very much like it in shape and color. The accompanying figures will serve to distinguish it, while the following technical description by Dr. Williston should be used for the exact discrimination of the species:

> *Male.*—Length, 3.5 to 4 mm. Sides of the front gently concave, its least width equal to one-fourth of the distance from the foremost ocellus to the base of the antennæ; in the middle a narrow dark-brown stripe; a single row of slender

bristles on each side. Antennæ brownish red; second joint slightly tumid; third joint a little longer than broad, with its inferior angle rectangular; arista swollen at the base (which is black), the pectination long. The narrow sides of the front and the still narrower facial and genal orbits silvery gray, with a slightly yellowish cast; facial foveæ and cheeks blackish, the latter clothed with yellowish hair. Palpi black, the inner surface and immediate base more yellowish; gently spatulate in shape, nearly as long as the proboscis and extending two-thirds of their length beyond the oral margin. Mesonotum subshining black in ground color, but mostly concealed beneath a brownish dust, which, on the pleuræ, is more grayish. Abdomen with similar dust; in the middle with a brownish, more subinterrupted stripe and narrow darker posterior margins to the segments. Femora black or very deep brown, first two pairs of tibiæ and tarsi brownish yellow or luteous, the hind tibiæ and tarsi blackish brown; hind tibiæ on the posterior surface with a noticeable, erect, subapical bristle; hind tarsi about as long as their tibiæ, the first three joints widened from their base to tip, so as to form a distinct serration on their inner, acute angles, each of which terminates in a long hair. Wings with a light blackish tinge (due to microscopic pubescence), the immediate base yellowish, the first posterior cell rather symmetrically narrowed to terminate broadly at the extreme tip of the wing.

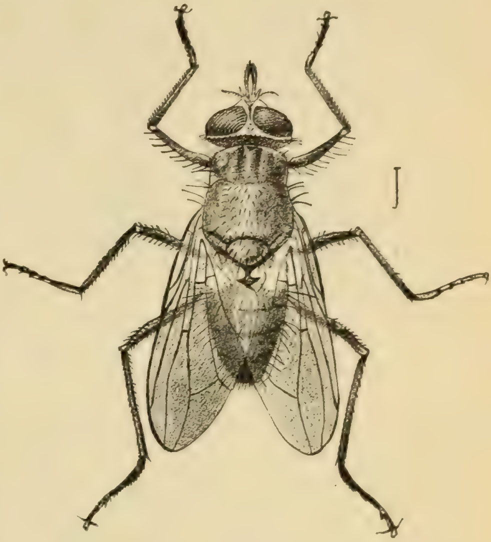

FIG. 58.—*Hæmatobia serrata:* adult in resting position—enlarged (from Insect Life).

Female.—Front straight on the sides, its width about equal to one-half of the distance from the foremost ocellus to the base of the antennæ; the median deep brown stripe about as wide as the pruinose sides. Palpi yellow, with the margins and tip blackish. Legs more yellowish; hind tarsi regular; pulvilli and claws small.

The flies are observed in greatest number in July, but appear as early as May, and remain till cold weather, the full time depending upon the season or latitude.

The characteristic habit of clustering about the base of the horn seems to exist only when the flies are quite abundant. When they average only a hundred or so to a single animal, comparatively few will be found on the horns. Moreover, as a general thing the horn-clustering habit seems to be more predominant earlier in the season than later, although the flies may seem to be nearly as numerous. The clustering upon the horns, although it has excited considerable alarm, is not productive of the slightest harm to the animal. Careful study of the insects in the field shows that they assume two characteristic positions, one while feeding and the other while resting. It is the resting position in which they are always found when upon the horns. In this position the wings are held nearly flat down the back, overlapping at base and diverging only moderately at tip. (See fig. 58). The beak is held in a nearly horizontal position and the legs are not widely spread. In the active sucking position, however, the wings are slightly elevated and are held out from the body, not at right angles, but approaching it, approximately an angle of 60° from the abdomen. The legs are spread out widely, and the beak, inserted beneath the skin of the animal, is held in nearly a perpendicular position, approaching that in figure 59, *c*.

The fly before inserting its beak has worked its way through close to the skin. While feeding, however, the hairs which can be seen over its body do not seem to interfere with its speedy flight when alarmed, for at a fling of the tail or an impatient turn of the head the flies instantly rise in a cloud for a foot or two, returning again as quickly and resuming their former positions.

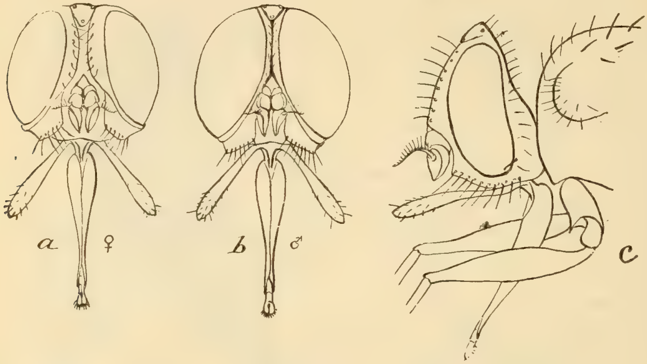

FIG. 59.—*Hæmatobia serrata:* *a*, head of female, front view; *b*, head of male, front view; *c*, head from side—all enlarged (from Insect Life).

The horns are not their only resting places, for with the horns black for 2 inches above their base we have seen the flies toward nightfall settle in vast numbers upon the back between the head and foreshoulders, where they can be reached by neither tail or head. When feeding they are found over the back and flanks and on the legs. During a rain storm they flock beneath the belly. When the animal is lying down a favorite place of attack seems to be under the thigh and back belly, around the bag. With certain animals the dewlap seems to be badly attacked, while with others this portion of the body is about exempt. Certain cattle, again, will be covered with flies and will lose condition rapidly, while others are troubled but slightly.

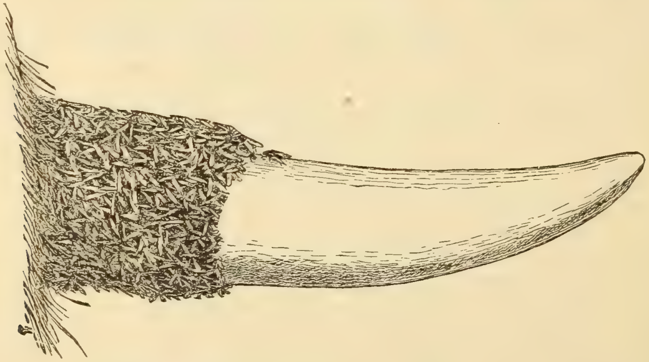

FIG. 60.—*Haematobia serrata:* cow horn showing band of resting flies—reduced (from Insect Life).

On the horns the flies settle thickly near the base, often forming a complete band for a distance of 2 inches or more. (See fig. 60.) They seem to prefer the concave side to the convex side of the curve of the horn, probably for the reason that the cow can not scrape them off so readily, and one cow was noticed in which they reached nearly to the tip of the horn on the concave side of the curve only.

The time and method of the deposition of the eggs were for some time a puzzle, but it was clearly shown in the investigations of the Division of Entomology that the eggs are placed in fresh cow manure in daytime, mostly between 9 a.m. and 4 p.m., and that in laying them the females dart only for an instant from the cattle, immediately after the dung is passed, and that within a little more than a minute afterward all had returned to the animal. They are laid singly, and never in clusters, and usually on their sides on the surface of the wet dung; seldom inserted in cracks. (Fig. 57, *a*.)

Egg.—Length, 1.25 mm. to 1.37 mm.; width, 0.34 mm. to 0.41 mm. Shape, irregular oval, nearly straight along one side, convex along the other. General color, light reddish brown, lighter after hatching. General surface covered with a hexagonal, epithelial-like sculpture, each cell from 0.027 mm. to 0.033 mm. in length by about half the width. In the unhatched egg, even in those just deposited, a long, rather narrow, ribbon-like strip is noticed along the entire length of the flattened side, rather spatuloid in shape. In hatching this strip splits off, remaining attached at one end, and the larva emerges from the resulting slit.

Larva.—After the eggs hatch, the larvæ descend into the dung, remaining, however, rather near the surface.

Newly hatched larva.—Length, 2.45 mm., and greatest width, 0.48 mm. Color, pure white. Joints of segments rather plainly marked, venter with slightly elevated ridges at ends of abdominal segments, the ridges with delicate sparse rugosities. Resembles in main full-grown larva.

Full-grown larva.—Length, 7 mm.; greatest width, 2 to 2.5 mm. Color, dirty white. Antennæ, 3-jointed, last joint pointed. Head with a lamellar or ridged structure shown in figure; divided by cleft at tip; skin behind lamellar structure coarsely granulated, while that of thoracic and abdominal joints is nearly smooth. Thoracic stigmata pedunculate with six pedunculate orifices. Ridges on venter of abdominal joints not strong, fainter than in young larva. Anal stigmata large, slightly protruding, very dark brown, nearly round, flattened on proximal borders, slightly longer than broad, 0.14 mm. in length, with one central round opening, and a series of very delicate marginal tufts of cilia, four tufts for each spiracle, each issuing from a cleft, but none on the proximal edge. Anal segment below with a dark yellow chitinous plate showing six irregular paired tubercles; the surface of the skin surrounding the plate rather coarsely granulated (fig. 57, *b*).

The larval stages are passed in from four to six days.

Puparium.—When ready to transform, the larvæ evidently descend from the dung into the ground below from a half to three-quarters of an inch. Actual observations were made on larvæ in dung in breeding cages where the soil was fine sand, affording ready entrance to the larvæ. Where the dung has been dropped upon hard ground the probabilities are that they will not enter so deeply, and may indeed transform upon the surface of the ground at the bottom of the dung.

Description.—The puparium is from 4 mm. to 4.5 mm. in length, by 2 mm. to 2.5 mm. in width, regularly ellipsoidal, the head rather more pointed; dark brown in color. The segments are plainly separated. The anal stigmata are darker in color than the rest of the skin; are slightly protruded and preserve the same shape as in the larva. The central opening is still visible, as are the slight indentations of the border. The ventral plate, noticed at the base of the anal segment of the larva is still noticeable as a series of tubercular elevations. (See fig. 57, c.)

The pupa stage may last from five to eight or ten days, so that the full time from egg deposition varies from ten to seventeen days, estimated for the average as about two weeks. As the flies doubtless begin egg laying soon after issuing from the pupa stage, there is room for a number of generations during even a northern summer, probably from six to eight being common.

REMEDIAL MEASURES.

While the injuries of this pest have abated after the first two or three years in all localities where it has appeared, it is doubtless here to stay, and must be looked upon as a permanent source of damage, the amount of injury varying with favorable or unfavorable conditions.

For its treatment two lines should be followed, one directed toward the protection of the cattle from the direct attacks of the flies, the other to the destruction of the larvæ, with a view to lessening the number of flies.

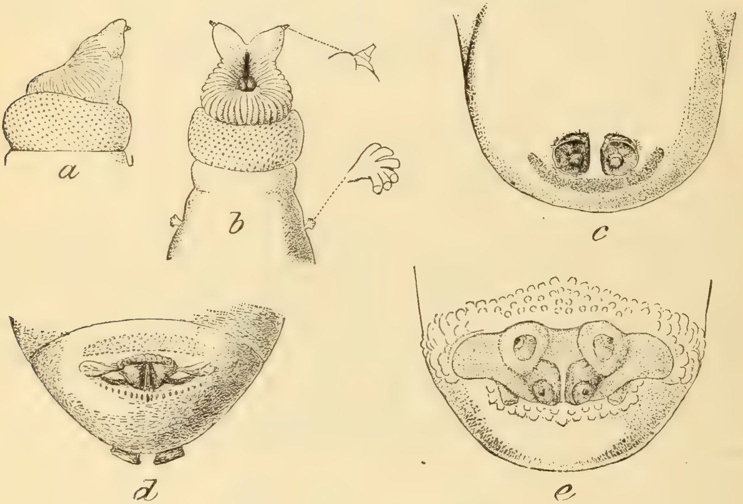

FIG. 61.—*Hæmatobia serrata:* *a*, side view of head of larva; *b*, ventral view of head of larva, showing antennæ and thoracic stigmata; *c*, dorsal view of anal end of larva, showing anal stigmata; *d*, anal plate of puparium; *e*, ventral view of anal end of larva, showing anal plate—still more enlarged (from Insect Life).

For the direct protection of cattle, the remedy most generally adopted, and which can be strongly recommended, is the daubing of the parts most affected with some sticky, offensive substance to repel the flies. Of these, a mixture of fish oil and tar, equal parts, is found one of the most permanent and effectual. Axle grease is used with good results. Spraying the animals with kerosene emulsion has been recommended, and if adopted should be applied at evening when cattle are yarded, a convenient method being to drive them through a gate at each side of which stands a man with spraying nozzle, so as to spray the flies of both sides at once. If only one nozzle is available the original suggestion of driving the cattle through a gate and then immediately back, so as to get the flies on the unsprayed side, may be adopted.

A plan which has been going the rounds of the agricultural papers is to arrange a trap in the doorway to a stable, the cattle, after passing the doorway, going through a set of brushes which dislodge the flies, which, with a properly arranged window above the door, collect at the light, and are here trapped and die.

A recent number of the Denver Field and Farm mentions a similar device being patented. It is intended for the capture of all flies gathering upon cattle, but would be especially useful for this species. The principle has been used so generally that there may be doubt as to its being patentable. (See chapter on remedies.)

For the destruction of the larvæ, which is probably the more effective way of preventing damage, two principles have been established. The first involves the killing of the maggots by introduction of some destructive agent; the other, the prevention of their maturity by the rapid drying of the mass of dung which supplies their food. The use of lime, as originally suggested in Insect Life, is a very effective plan, and where not prohibited by expense should be generally adopted. Professor Smith's suggestion to spread out the droppings of manure so that they may dry rapidly is applicable during dry weather and in some localities is accomplished by drawing brush across the fields, a method which must necessarily fail to be complete in its operation, but much less expensive than the use of a shovel by hand.

THE FLESH FLY.

(*Sarcophaga carnaria* Linn.)

While this species is perhaps better known as a household pest attacking fresh meat, the fact that it often deposits its eggs in the wounds of living animals makes it an important pest of domestic animals.

It has been a familiar insect probably ever since man began to appreciate the insect foes to his comfort, and has been a common subject of treatment in writings upon insects from a very early date.

It was technically described by Linnæus in 1761, and its habits were already doubtless well known.

Its life history is easily told, and to some extent probably familiar to everyone who has had to do with the handling of fresh meats.

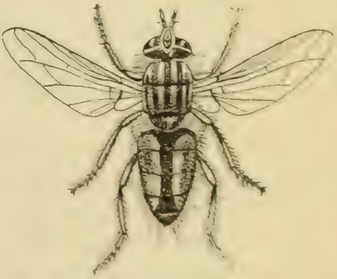

FIG. 62.—Flesh fly, *Sarcophaga carnaria* (redrawn from Van Beneden.)

Living larvæ are deposited by the females upon any available bit of fresh meat, including wounds of animals, and these feed and develop with astonishing rapidity, soon consuming large quantities of flesh and, upon attaining their growth, crawl away, secrete themselves in the first convenient shelter, remain a few days in the pupa stage and issue as adults.

It is evident that in the primitive conditions of nature, or in localities where people are indifferent to the exposure of the carcasses of dead animals, these creatures may perform an important function, disposing of carcasses in a short time which otherwise would contaminate the atmosphere for many days.

When infesting the storehouse, however, or attacking the wounds of domestic animals, the case is very different and the insect requires prompt subjection.

For stock it is important to prevent, as far as possible, the occurrence of cuts, bruises, or wounds of any kind which may furnish an attraction for the flies, and to guard against injury from barbed-wire fences or the horns of cattle. Wounds when formed should be dressed with dilute carbolic acid and coated with tar to prevent deposition of eggs, while if already infested with the larvæ the wounds should be carefully cleaned, washed out with the carbolic acid solution and dressed with tar to prevent further egg deposition.

Probably the most common American species is *S. sarraceniæ* Riley.

THE STABLE FLY

(*Stomoxys calcitrans* Linn.)

This well-known species is widely distributed and a familiar pest in many countries. It was described by Linnæus in 1761 (Syst. Nat., 2, 1004) and has been mentioned in numerous works since then, Geoffroy, DeGeer, Fabricius, and many others noticing it, and it is unnecessary to go into detail with regard to its bibliography here.

Its bite is severe and it causes a great amount of annoyance to cattle, horses, and other domestic animals, and it is frequently very troublesome to people working in places where it abounds. It is not confined to stables or the quarters of domestic animals, but occurs frequently in shady places, groves, and in dwellings, especially in cloudy weather, and puts the occupants to great inconvenience. Its bite is not poisonous, and aside from the pain given and the possibility of it disseminating disease, it is less injurious than some other members of the group. When abundant, however, this annoyance may be very great, and they all deserve attention. Indeed, it is especially charged against this species that they have been the means of transmitting glanders from diseased to healthy horses and anthrax among cattle, a charge which appears very reasonable from the fact that it inflicts a deep bite and does not gorge itself at a single animal, but may fly from one to another in securing a meal.

It does not appear that the life history of this species has been fully recorded, although it has been stated that the stages are probably passed in dung. In connection with the studies of the horn-fly by the Division of Entomology this species was reared with others from horse manure, and it may be considered as established that the eggs are laid in dung and the larval stages passed there, requiring greater or less time for their development, a number of generations being produced each year. The prompt disposal of dung would therefore help greatly in reducing the numbers of this pest.

THE MEAT FLY OR BLOW FLY.

(*Calliphora vomitoria* Linn.)

This fly agrees quite closely with the flesh fly in habits, except that it deposits eggs instead of living larvæ. The eggs, however, hatch very quickly after deposition, so the effect is very much the same. Like that species it has long been known as a troublesome insect and was described by Linnæus. It is a large species and familiar as the large blue fly which so noisily frequents the window or seeks entrance to pantries, cellars, and storerooms where eatables are kept.

With that species also it is credited with attacking fresh wounds, and Packard states that during the war of the rebellion they were grievously tormenting to our soldiers, laying their eggs in the wounds, especially of those left on the field over night.

On domestic animals where these "fly blows," as they are commonly called, occur, the same treatment suggested for the flesh-fly may be practiced.

BLUE-BOTTLE FLY.

(*Lucilia cæsar* Linn.)

In history and habits this species is very similar to the preceding species and it is unnecessary to go into detail with regard to it. It is one of the first to put in its appearance in spring, having lived through winter in some sheltering corner. Its eggs are deposited upon any available fleshy matter and the larvæ mature rapidly.

Packard, in mentioning its habits, says:

> Dr. Chapman, of Apalachicola, writes to Mr. Sanborn that this fly, attracted by the stench of a mass of decaying insects which have perished in the leaf of Sarracenia, ventures in and deposits its eggs, and the larvæ devour the festering heap. These in turn, on becoming flies, are unable to get out of their prison, perish, and are added to the putrefying mass that had nourished them. (Guide, p. 104.)

THE SCREW-WORM FLY.

(*Compsomyia macellaria* Fab.)

The screw-worm is unquestionably one of the most important of all the insects that affect domestic animals, and while the literature of the subject deals largely with its attacks upon man, on account of its very general fatality when gaining entrance to the openings of the face, by far the greater number of its attacks are upon the lower animals, and it is principally in this connection that we purpose to discuss it here, including such reference to its hominivorous attacks as may furnish aid in understanding its mode of work.

The recognition of the injurious nature of the insect appears to have been in the early days of American settlement, and its description has occupied the attention of numerous naturalists. Indeed, it has an appalling synonymy, no less than twenty-six names having been applied to forms which are considered by good authorities as representatives of this species.

It will be useless to attempt here a discussion of this synonymy, but I may quote from an article by Dr. Williston [1] the more important points in this connection, along with an extract from a Spanish article on the subject, and simply add here that valuable contributions have been made to the knowledge of its attacks on domestic animals by Prof. H. A. Morgan,[2] of the Louisiana Experiment Station, Prof. H. E. Weed,[3] of the Mississippi Experiment Station, and Dr. M. Francis,[4] of the Texas Station, whose papers will be drawn from in discussing certain phases of the subject.

Dr. Williston's article is as follows:

> In connection with Professor Snow's article on this fly[5] it seems worth while to give a brief synopsis of papers published in the past few years by the able dipterologist of South America, Dr. E. L. Arribálzaga, of Buenos Ayres. From his studies he has ascertained no less than twenty-six different specific names that this fly had received. It is possible that some of these names would apply to distinct species were their types examined, but it is a thankless task to endeavor to make order out of the chaos in which Walker, Macquart, and Robineau-Desvoidy have involved the subject, and the results of Arribálzaga's thorough studies can with propriety be adopted. To these results, however, Mr. J. Bigot, of Paris, has recently taken exception in a note[6] on Professor Snow's paper. This author's penchant for making synonyms himself may perhaps have something to do with his wishing to preserve species founded on inadequate grounds. His argument that "il me semble fort hasardeux d'avancer qu'un seule et même espèce se retrouve, en permanence, depuis les confins de la Patagonie jusqu'au delà des provinces centrales de l'Amérique du Nord, vivant indifféremment sous les zones torrides, tempérées et même froides!" is of little value, when the author himself should know that other American flies *do* have a similar range of habitat, to say nothing of the nearly allied *Musca domestica.*
>
> The specimens which Professor Snow sent me for examination, although somewhat injured, certainly seem to me to be *Compsomyia macellaria* (Fab.) E. Lch. A. The species may, with tolerable certainty, be recognized by its having a bright metallic green or coppery color on the abdomen and thorax, the latter above with three black stripes; the bristle of the antennæ feathered to the tip, and the head, except the eyes, chiefly yellow. In size it varies from 7 to 10 millimeters.
>
> However, these systematic details will be of less interest than the following, which I translate from the Spanish of Arribálzaga:[7]
>
> "During the pleasant days of spring or the hotter ones of summer, these flies may be seen covering in great numbers, now umbelliferous flowers, now all sorts of filth; or, resting, there glistens in the sunlight the iridescent surface of their half-opened wings, and the blue, the green, the violet, the copper, and the gold of their metallic colored bodies.

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[1] Psyche, Vol. IV, pp. 112–114.

[2] Bulletin No. 2, 2d series, Louisiana Experiment Station.

[3] Bulletin No. 14, Mississippi Experiment Station (1891).

[4] Bulletin No. 12, Texas Experiment Station (1890).

[5] Psyche, Mar.–Apr., 1883, Vol. IV, pp. 27–30.

[6] Bull. Soc. Entom. France, 12 Sept., 1883, No. 17, pp. 154–155.

[7] Anales de la Soc. Científica Argentina, Vol. X, pp. 80–84.

"Our fly deposits its egg, commonly called "*queresa*," in dead bodies, in manure, in fresh meat reserved for food, and soon there appear immense numbers of voracious larvæ that rapidly consume the objects in which has begun their active life. Not content with these habits, common to all the species of the group to which it pertains, it deposits the germs of its posterity in the wounds of man and of animals, at the entrance of openings of the human face, and, in its anxiety for propagation, will deposit them in the wool of sheep.

"Azara was, I believe, the first observer who noted cases of human myiasis in South America. Coquerel, many years later, called the attention of physicians and naturalists to the frequent and fatal accidents which this evil produces among the exiles of Cayenne. According to this author, Dr. Chapuis, physician in chief of the French marine, attended one case in which the larvæ of *C. macellaria* had penetrated to the frontal sinuses, causing the death of the patient; also one very unclean person attacked in the nasal fossæ and the pharynx, who succumbed after he had ejected one hundred and twenty larvæ. There were, as M. St. Pair observed, in the same country, six similar cases, of which three terminated in the death of the patients after cruel sufferings; in two the nose was destroyed, and in the last there was a deformation of the olfactory organ. In another case observed by M. St. Pair there were removed, by means of injections, more than three hundred larvæ, but he was not able to obtain them all, and the remainder soon penetrated the ball of the eye, destroying the lower eyelid in consequence of gangrene, invaded the mouth, corroded the gums, and laid bare the inferior maxillary. The victim died seventeen days after his entrance into the hospital."

After giving records of numerous other cases, he further adds:

"To Dr. Lesbini, of Cordova, are due the better observations upon cases of myiasis produced by *C. macellaria*. The first case presented itself in an old foreigner who had an ulcer in his leg filled with these larvæ; the second case occurred in Cordova, in a boy of 7 years, attacked in the left ear; the third and last case was in a girl of 16 years, also of Cordova, affected in the nasal fossæ by the presence of two hundred and fifty larvæ. All these patients were saved.

"It is probable that, attracted by the fetid odor of unclean individuals, these flies hover over the mouth or the nose, and thus deposit their eggs. Some affirm that they at times enter the passages for this purpose.

"The area of distribution of *Compsomyia macellaria* is very great, and will be, I believe, yet greater with time, since their habits facilitate their transportation by man from one region to another. Hitherto they have been observed in the following countries: Islands of America (*Musca macellaria* F.), North America (*Chrysomyia tibialis, C. l'herminieri, C. cærulescens, C. decora, C. plæi* R.-Desv.), Mexico (*Lucilia hominivorax*), Cuba, Colombia, Venezuela, Cayenne, Brazil, Peru, Chile, Uruguay, Argentine Republic, and New Holland."

DISTRIBUTION.

It will be noted in the preceding paragraph that the species is credited to all of America between Patagonia and Canada, but the territory within which the greatest damage occurs is within the tropical and subtropical belt. Weed states that the fly is killed by cold winters, which, if correct, means a barrier to its northward extension beyond what is possible in each season by migration of the flies.

HABITS AS A PEST OF MAN.

In discussing the habits of the species it will be convenient to discuss it with reference to the attacks upon the human species and domestic animals independently.

The attacks upon man are usually due to deposition of eggs in the nostrils or mouths of sleeping or unguarded individuals, though no doubt exposed sores or bruises having a bloody surface would be equally attractive.

Professor Snow[1] has given a very careful description of the attacks and results in a number of cases, and it will be useful here to extract from his paper some of the especially typical cases as showing the mode of attack, the effects of the presence of the larvæ, and the treatment resorted to:

> I have from time to time had occasion to note the depredations of the screw-worm upon horses and cattle in this State, but until recently have not received positive evidence of its attacks upon human subjects in any locality so far north as Kansas. But early in September, 1882, I received from Mr. S. D. Osborn, the postmaster at Varck, in southeastern Kansas, specimens "of the worms which came from the nostrils of Milton Carter." These proved to be the larvæ of *Lucilia macellaria* Fab., the so-called "screw-worm." Upon further inquiry, I learned that upward of one hundred full-grown maggots escaped from the nose of this patient, who finally recovered from the serious illness consequent upon their ravages. I also ascertained that Mr. Carter had long been afflicted with an offensive nasal catarrh, which made his nostrils an attractive place for the oviposition of the fly, and that he had fallen asleep in the woods in the daytime only a few days before the first appearance of the symptoms produced by the presence of the larvæ.
>
> Several other instances of the attacks of *Lucilia* upon man soon came to my knowledge, most of which led to fatal results. Among these I will select the case attended by Dr. J. B. Britton, of Mapleton, in southeastern Kansas, who reported it in full at the session of the Southeast Kansas District Medical Society, in January, 1883. From this report I condense the following account:
>
> "On the evening of August 22, 1882, Mr. M. E. Hudson complained of a peculiar sensation at the base of the nose and along the orbital processes, which was first followed by inordinate sneezing, and later by a most excruciating pain over the os frontis, also involving the left superior maxillary. This patient also had suffered, and was still suffering, from an aggravated form of nasal catarrh. The discharge was quite purulent, of a yellowish color, frequently tinged with blood, with a disagreeable odor and at times intolerably offensive. On the 24th there was a profuse discharge of much purulent matter from the nostril and mouth, when all pain instantly subsided. This discharge continued for three days, during which time as much as 16 ounces escaped, increasing in consistency until it was pure pus. The odor becoming much more offensive, his cough was more troublesome, and fever increased to such an extent as to produce slight delirium for twelve hours. What was thrown off was with much difficulty expectorated, and was sanious, containing microscopic particles of osseous matter, together with flakes of plastic exudation. The os hyoides was evidently destroyed. The patient had spoken with difficulty for thirty-six hours and there was much trouble in swallowing. The soft palate had evidently given way, and there was an entire inability to protrude the tongue or use it in speech.
>
> "About this time a worm similar to a maggot dropped from his nose. That was the first indication or suspicion that there was anything of the kind present. There was not, as in some other cases reported, any swelling, or movements traceable under the skin, nor was there at any time any complaint of the patient calculated to lead to a knowledge of their presence. After the appearance of the first I expected more, and was surprised to see them drop from the nostrils and wiggle from the mouth without any discomfort to the patient until they came in contact with the

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[1] Psyche, Vol. IV, p. 27 (1883).

Schneiderian membrane, when they annoyed him greatly, and every effort was made on his part to expel them; but so soon as expelled no further trouble was manifested until another would get into the nostril. Every effort was made on my part to discover them under the tissue, but the soft palate being destroyed to a great extent, and the palatine arch apparently lowered, it was with much difficulty that an examination could be made. The worms were evidently burrowing under the palatine fascia, as it presented a honeycombed appearance and in places patches were totally destroyed as large as a dime [18 mm.]. They continued to drop from the mouth and nose, forced from the nostrils by the efforts of the patient, for the following forty-eight hours, during which time 227 were counted and the estimated number exceeded 300. At this time the whole of the soft palate was destroyed. The patient lived four days after the last worm came away.

"I put five of the worms in dry earth, and in fourteen days from the time they dropped from the nostril there hatched out three flies.

"Upon a very minute and careful examination after death I was astonished to find that all the tissue covering the cervical vertebræ, as far down as I could see by throwing the head back and compressing the tongue, was wholly destroyed and the vertebræ exposed. The palatine bones broke with the slightest pressure of the finger. The os hyoides was destroyed and the nasal bones loose, only held in position by the superficial fascia.

"My own theory is that the fly deposited the eggs while the patient was asleep, probably the day previous to the peculiar sensation and sneezing first complained of. At that time they had acquired vitality enough to annoy him while in contact with the sound flesh. So soon as they came in contact with the unsound flesh, or that affected with the catarrh, being, as it must have been, gangrenous, they gave no further trouble." * * *

In the Peoria (Ill.) Medical Monthly for February, 1883, Dr. Joshua Richardson, of Moravia, Iowa, has an article upon "The Screw Fly and its Ravages," from which I make the following extracts:

"While traveling in Kansas in the latter part of last August, a citizen of this place had the misfortune to receive while asleep a deposit of eggs from this fly. He had been troubled for years with catarrh, hence the attraction to the fly. He returned home a few days after the accident and shortly after began complaining of a bad cold. Growing rapidly worse, I was called to attend him. Monday, my first day, his appearance was that of a man laboring under a severe cold. Had slight congestion of the lungs, and moderate grade of fever. His nose seemed greatly swollen and he complained of a smarting, uneasy feeling in it, and general misery through the head. Gave him treatment to relieve the congestion and fever. Tuesday, saw him again. His nose and face were still more swollen, and in addition to the other symptoms he was becoming slightly delirious and complained a great deal of the intense misery and annoyance in his nose and head. A few hours after, I was sent for in haste with the word that something was in his nose. I found on examination a mass of the larvæ of this fly (or "screw-worms," as they are commonly called in the South) completely blocking up one nostril. On touching them they would instantly retreat en masse up the nostril. Making a 20 per cent solution of chloroform in sweet milk I made a few injections up both nostrils, which immediately brought away a large number, so that in a few hours I had taken away some 125 of them. By Wednesday evening erysipelas had begun, implicating the nose and neighboring portions of the face. Another physician was called. By continual syringing with a strong antiseptic solution of salycilate of soda, bicarbonate of soda, and carbolic acid we hoped to drown out the remaining larvæ. But they had by this time cut their way into so many recesses of the nose and were so firmly attached that we were unable to accomplish much. Finally we resorted to the chloroform injections, which immediately brought away a considerable number. Friday I was able to open up two or three canals that they had cut, extracting several more that had literally packed themselves, one after another, in these fistulous channels. His speech becoming suddenly much worse, I examined the interior of his mouth and found that a clear-cut opening had been made entirely through the soft palate into his mouth and large enough to insert the end of a common lead pencil. Saturday the few remaining larvæ began changing color and one by one dropped away. On Sunday for the first time hemorrhage from both nostrils took place, which continued at intervals for three days, but was not at any time severe. On this day the patient began to improve, the delirium and erysipelas having subsided, leaving but little or no annoyance in his head. In a few days he became able to go about home, and even to walk a distance of half a mile to visit a friend and return. But while there he began complaining of a pain in the neighborhood of his left ear, apparently where the eustachian tube connects with the middle ear. It proved to be an abscess. Being already so reduced by the first attack, he was unable to withstand the second, and died after an illness of nearly three weeks, completely exhausted by his prolonged sufferings. Three days before his death the abscess discharged its contents by the left nostril. The quantity of pus formed was about 2½ ounces [78 grams].

"In all about 250 larvæ were taken away from him during the first attack, and, as the visible results, not only had they cut the hole through the soft palate, but had also eaten the cartilage of the septum of the nose so nearly through as to give him the appearance of having a broken nose. The case occupied, from the first invasion of the fly to its final result, nearly two months. He doubtless would have recovered but for the formation of the abscess, which, from all the symptoms, was caused by one or more of the larvæ having found their way up the left eustachian tube."

Dr. Richardson also quotes the Rev. William Dixon, of Green, Clay County, Kans., as giving the following account of his own experience:

"While riding in his buggy a few years ago in Texas a screw fly attacked him, flying up one nostril. He blew it out, when it dashed up the other and deposited its eggs before he was able to expel it. Not realizing the danger, he did nothing for about three days, when the pain became so great that he hastened to Austin to consult a physician. His soft palate was almost destroyed before the larvæ, over 200 in number, were expelled."

This was the only one of twelve cases known to Dr. Richardson in which the patient recovered.

AS A PEST OF DOMESTIC ANIMALS.

Until recently the references to the attacks of this species on domestic animals have been of a very fragmentary character, but the papers by Morgan, Weed, and Francis have brought its true importance into prominence.

Its greatest injuries for the United States have occurred in Texas, and the Texas Experiment Station early began the study of its habits. Prof. G. W. Curtis, formerly director of that station, wrote to me at considerable length regarding the pests, kindly sending me specimens of the various stages, and I can hardly better present the relation of the pest to the stock industry of that State than to extract from a letter dated December 15, 1888:

I am sorry I have not more time to answer your questions about the so-called "screw-worm" of Texas.

I have been closely interested in practical stock raising in this county for nearly six years; always in charge of the college stock and part of the time privately with stock of my own, and I am free to confess that the man who can find a cheap, expeditious, and effective preventive or remedy of the screw-worm will confer a blessing fitly measured by the enormous financial benefit which would accrue.

My observations have been mainly concerned with the practical side of the subject, and not until the past year or two have I taken much trouble to investigate the life history of the insect.

As a rule, the fly begins its work in June, but nothing like vigorous business activity is reached until July, when for three or four months the time of the stockman is kept constantly absorbed in attending to animals with "wormy" sores. This year (1888) the most trouble was experienced during September and October, and out of some 200 head of cattle and 60 or 70 head of hogs we had as many as 15 or 20 cases under treatment in a space of less than two weeks.

The trouble starts usually by some little scratch, perhaps caused by barbed wire or by a stroke from a horn; sometimes, frequently in fact, it starts by an undue accumulation of ticks and consequent rubbing of the animal, which, while removing some of the ticks, leaves an opening in the skin through which a little blood will exude. In either case the basis of the operation seems to be a raw or slightly bloody surface, and the rapidity with which the work is carried on is wonderful. The eggs are deposited and the larvæ appear in a very short time; from what I have noticed I should say in less than thirty-six hours after the egg is deposited.

I have been told, time and again, by those who assume to know, that the "screw-worm fly" does not deposit the eggs—that they are hatched within the body and the young larva deposited after hatching. There is a gray fly which does this, but the female deposits only a few larvæ, and they are not by any means to be dreaded so much as the green fly (brown head), which deposits eggs by the wholesale.

I have never seen a "screw-worm" (larva) which I could trace directly to a gray fly. All of the worms which I have bottled up and hatched under positive guard against error have turned into the same kind of fly, specimens of which (in alcohol) are herewith transmitted for your examination.

It is said, however, that the gray fly works earlier in the season. This may be true, as the flies I have hatched out have been from worms taken from sores during September and October.

In October of this year a house cat which I have had his foot injured, presumably by fighting. When we next saw him, about three days later, his foot was swollen and filled with screw-worms. We took out over 60 screw-worms from his foot within six days. All of these were placed in a bottle with a little earth and covered by a wire screen.

The worms pupated and transformed in twelve days, about 30 flies coming out; all like the flies sent you.

During the few days that the worms were in the cat's foot they divested the bone of almost every particle of flesh and caused one of the phalangeal bones to come out entire.

About a week after this I bought a thoroughbred Hereford calf and had him shipped down from the northern part of the State. On arrival I found screw-worms in the cleft of the right front foot (between the toes), produced by some fly in Dallas, as he was shipped directly from that point, and had been there for two weeks or more prior to date of shipment. I took out some 12 or 15 of these worms and "planted" them very carefully. I did not know but the fly in north Texas might prove to be the gray one, and I was anxious to satisfy myself on this point.

Some 10 or 12 of the number "planted" transformed and the flies appeared in eleven days from date of planting, all green with brown heads, exactly like the ones I had found in the cat's foot, and which must, of course, have been deposited by flies in this immediate vicinity. * * *

Dr. Francis (Bull. 12, Tex. Exp. Sta.) states that no cases in man have fallen under his notice, and says:

Of all our domesticated animals cattle suffer the most from its ravages. They occur in wounds from horns, castrating, spaying, branding, dehorning, barbed-wire injuries, and often where ticks have burst on the brisket, flank, or just behind the udder of cows. They often occur in the vulvæ of fresh cows, especially if there has been a retention of the placenta or afterbirth. Young calves are almost invariably affected in the navel, and often in the mouth, causing the teeth to fall out. One case occurred in the first stomach (paunch or rumen) that is worthy of mention. Last September the writer had occasion to kill a Jersey bull calf probably two months old that had screw-worms in both hind legs just above the hock joint. On opening the abdomen I found hair balls in the stomach (rumen), and, to my surprise, about twenty-five fully matured screw-worms almost buried in the wall of that organ. I placed some of the worms in moist earth, and in ten or twelve days they hatched out genuine screw-worm flies. How did they come there? My opinion is that the calf licked the sores on his legs, and in doing so took some eggs that hatched and developed in the stomach.

Horses and mules are not so often attacked. In them they are usually found in barbed-wire injuries, and occasionally in the sheaths of horses and the vaginæ of mares and the navels of colts.

Hogs are more liable to become affected than horses. They are frequently wounded by dogs and by fighting, or there may be barbed-wire injuries, wounds from castration, etc.

Sheep are comparatively free from the attacks unless injured by dogs.

Weed considers that next to the attacks upon man those upon cattle are of most importance, and he estimates that half of the cases in cattle occur where ticks have been crushed. He also states that "sheep are attacked when injured by dogs, or when the sheep are in poor condition the eggs are laid upon the wool and when the larvæ hatch they immediately bore into the skin. In many cases the sheep are attacked within the nasal cavities and the worms eat into the head." On hogs he says the favorite seat of attack is upon the ears.

LIFE HISTORY.

The fly which produces all this trouble is a small species less than half an inch in length (10 mm.) and of a bluish green color with metallic reflections. It is particularly distinguished from related forms by the presence of three longitudinal black stripes on the thorax. The head is reddish or yellow and the body is covered with stiff black hairs.

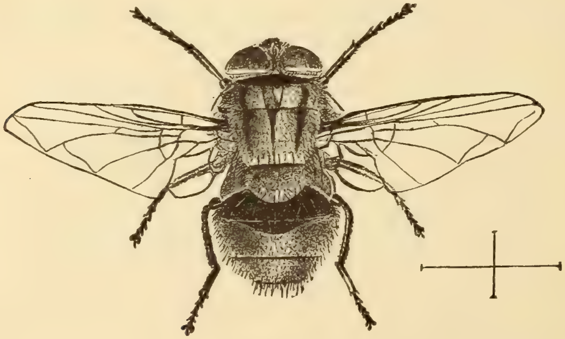

FIG. 63.—*Compsomyia macellaria:* adult, wings expanded—enlarged (after Francis).

The fly appears in early summer (June or July for Texas), the time doubtless depending on the latitude, it having passed the winter as adult presumably either in a latitude free from extreme cold or a protected location in houses. There is no impossibility of the migration of these flies from localities several hundred miles south of the place of their appearance in early summer, as aside from the powers of flight they could easily be transported on boats or cars. I know of no observations, however, to establish such a means for their distribution.

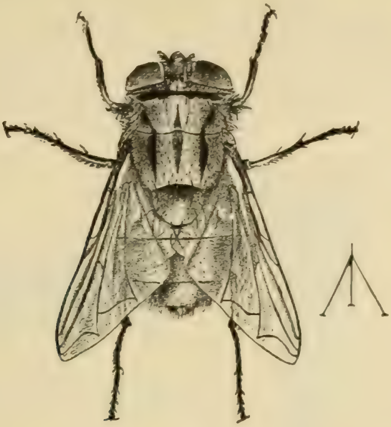

FIG. 64.—*Compsomyia macellaria:* adult, wings at rest—enlarged (after Francis).

In depositing its eggs it selects some wound or decaying matter and lays a mass of eggs at once; at least three or four hundred may be deposited by a single female within a space of a very few moments, and the same fly may oviposit at different times and in different places hundreds or even thousands of eggs.

The eggs are cylindrical, like those of other flies, about 1 mm. in length, white. "Under the microscope the eggs show a prominent ridge on one side." (Weed.)

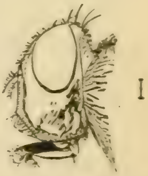

FIG. 65.—*C. macellaria:* head, side view—enlarged (after Francis).

The eggs hatch within a few hours. Francis says:

> My present opinion is that if the eggs are laid in a moist place and on a warm day it requires less than one hour; whereas if laid in a dry place they seem to dry up and lose their vitality.

Weed considers the time required for hatching about nine hours. The idea that they may be deposited in living condition is combated by all careful observations. The larva, or maggot, is a whitish footless grub, rather slender and quite active, burrowing into the tissues of the affected animal or into the mass of putrid flesh or decaying matter that furnishes it food. They grow rapidly and mature in five or six days (Weed) or about a week (Francis). When mature they escape from the wound they have infested or wriggle away from the mass of matter in which they have developed, and bury themselves in the ground to transform.

The puparia are brown in color, cylindrical, rounded at the ends, and about two-fifths of an inch in length. (See fig. 69.)

The length of time passed in the pupa stage appears to vary, but observers agree on from nine to twelve days as the usual time; Francis says nine for the shortest and fourteen for the longest period observed by him. From this history it is evident that there may be a succession of many generations during a season, which for different individuals so overlap and combine that there are hosts of the insects in all stages, from their appearance in the early part of the season till checked by return of cold weather. As Francis says:

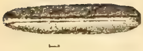

FIG. 66.—Egg of *C. macellaria*—greatly enlarged (after Francis).

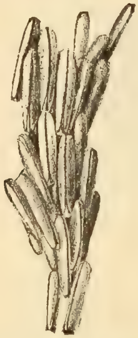

FIG. 67.—Egg mass of *C. macellaria* (after Francis).

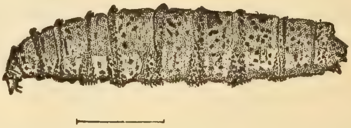

FIG. 68.—Larva of *C. macellaria*—enlarged (after Francis).

> While the larvæ are thus developing, the flies are constantly laying fresh eggs in the wounds, so that the young worms take the places of the matured ones, and thus keep up a constant and progressive loss of tissue.

REMEDIES.

It is evident from the above accounts that the fatal cases in man are due to the deposition of eggs, mainly in the nostrils, sometimes in the mouth, and that such deposition is most liable to occur to persons sleeping in the open air or to those suffering from catarrh. The evident precaution is to avoid these sources of danger by the use of mosquito netting or wire gauze for sleeping rooms and of a protection for the nostrils when exposed in places where the flies are common.

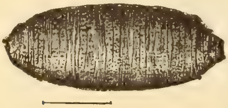

FIG. 69.—Puparium of *C. macellaria*—enlarged (after Francis).

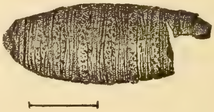

FIG. 70.—Puparium of *C. macellaria*, showing broken end where fly has emerged—enlarged (after Francis).

If once infested, medical attention should be sought at the earliest possible moment, and in case of delay a prompt syringing out of the nasal passages with dilute carbolic acid, 1 part acid to 200 parts water, should be resorted to to dislodge or kill the worms.

For the general abatement of the pest, attention to the destruction of garbage. carcasses, or filth of any kind is to be commended, while prevention of bruises, cuts, barbed-wire scratches, and especially the punctures of ticks, are among the most important measures. Weed and Francis agree that ticks furnish the greatest number of cases, and the former advocates the feeding of salt and sulphur as a preventive of ticks on this account. Francis, however, considers the sulphur treatment of no avail, but depends upon killing ticks with dipping, a process which must serve to kill ticks, lice, screw-worms, and all external parasites at once. (See section on dipping methods.)

As a direct application for the sores infested with worms. a wash of carbolic acid is advised. The acid should be diluted with thirty times its bulk of water, and its value would, I suspect, be enhanced if a little glycerin were added. A final dressing of pine tar or in deep sores a packing with oakum and coating with tar are recommended.

Dr. Francis writes me that since the publication of his Bulletin on screw-worms they have found a very practical method of applying substances to destroy the larvæ. It is to use creoline, or any of the carbolic sheep dips, in a machinist's oiler, by which means one can deliver a few drops in the holes without waste. They use an ordinary conical zinc oil can of about 4 ounces capacity, and find it very satisfactory.

SUMMARY.

In brief, it may be said that the screw-worm fly. which is distinguished by blue body, red front to head, and three black lines on the thorax, is distributed through all of tropical and much of temperate America; that it deposits eggs (not living young) in refuse matter. carcasses of animals. flesh wounds, or even minute drops of exuded blood. and the exposed openings of the body; that the eggs hatch within a very few hours at most, and larvæ grow to maturity rapidly, consuming all tissues adjacent to them, and in cases of attack upon the limbs often laying bare the bones; that pupation lasts about ten or twelve days and is passed underground; that adults are found through nearly all the summer months, but for the southern United States more particularly from July to October; that for prevention and remedy reliance must be placed upon the prevention, as far as possible, of all wounds and filth on animals, and when infested, prompt treatment with washes of dilute carbolic acid and subsequent coating with pine tar.

THE TSETSE FLY.

(*Glossina morsitans* Westw.)

This famous fly of the central plains of Africa can hardly be omitted from a work of this character, especially since there is a possibility of its distribution to other countries. Even now it is thought to exist in Australia.

Its attacks upon cattle, horses, mules, sheep, as well as numerous wild animals—zebras, antelopes, buffaloes, etc.—are said to be most deadly in result, and even man is attacked with severity, though it is claimed that these attacks are less injurious to man than to animals.

Other species of the genus have similar habits, but are less known.

THE HIPPELATES FLIES.

(*Hippelates* spp.)

Under the title of The Hippelates Plague in Florida[1] Mr. E. A. Schwarz has called attention to a group of insects that must have a very important place in the list of animal plagues, though they seem to have been pretty generally neglected. His treatment of the pest is almost entirely from the standpoint of their attacks upon human beings, but it is clearly shown that they must be a dangerous pest to domestic animals as well. There can be no doubt that these insects have been commonly met with and noticed as a source of annoyance, but no one seems to have made a study of them from the economic standpoint before Mr. Schwarz.

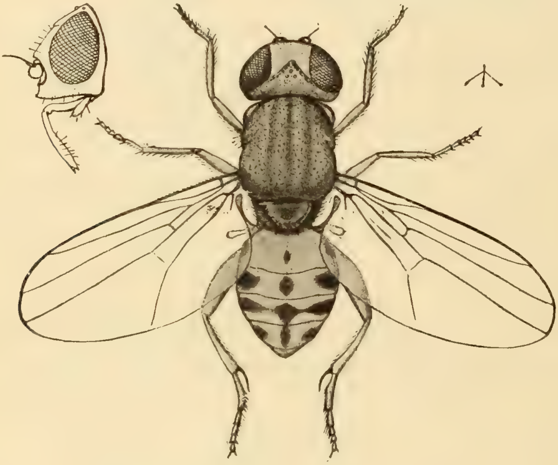

FIG. 71.—*Hippelates flavipes*—much enlarged (from Schwarz).

The species especially mentioned are: *Hippelates plebejus* Loew, *flavipes* Loew, and *pusio* Loew, two of which are figured and the figures are here reproduced.

The annoyance caused by the flies is due to their darting into the eyes and other parts of the body after the moisture or perspiration, and also by a constant humming. They prove very irritable. Further, they attack sores, scratches, ulcers, etc., and by passing from one person to another, or from dogs, cats, or other animals with sores to healthy individuals, become a most dangerous source of disease contagion.

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[1] Insect Life, Vol. VII, pp. 374-379.

So far as described the plague is greatest in the Southern States, especially Florida, Alabama, and Texas, and as similar species are common to many parts of the country, there is little doubt that when investigated many of the annoying gnats will be found to come within this group. Indeed, I feel confident that in years past insects of this character have been often encountered in the Mississippi Valley, as the hard bodies and persistent efforts to enter eyes have been noted, when no attempt was made to collect specimens or place them entomologically.

> The flies are strictly diurnal, and continue to be troublesome from early morning till near sunset, being most aggressive during the hot and sultry hours of the afternoon. They preferably frequent open and sunny places, while in the shade of dense forests their presence is not noticeable. They are equally troublesome in the country away from human habitations, and in the streets of small towns, but I do not recollect having seen them in any number on the streets of the larger cities. They enter the houses, but evidently do not feel at ease in the rooms, for they do not attack people, but congregate on the panes of windows, if these happen to be closed.

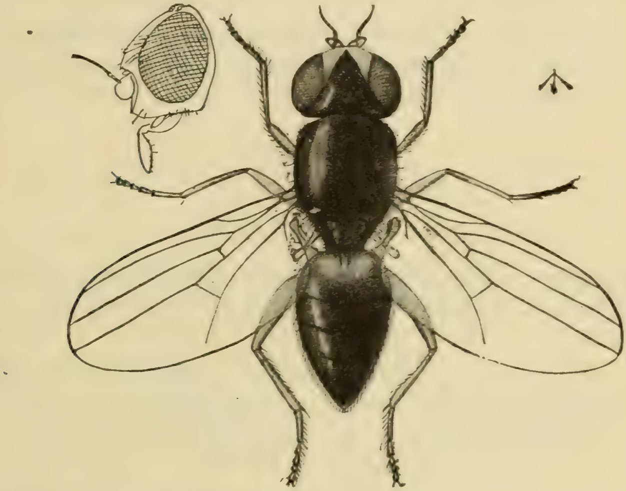

FIG. 72.—*Hippelates plebejus*—much enlarged (from Schwarz).

The life histories are unknown, but Mr. Schwarz suggests the stems of reedy plants or the piles of decaying reeds along shores of lakes or marshes as possible breeding grounds.

With regard to remedial measures Mr. Schwarz says:

> Until some light is thrown on the life history of the flies it is impossible to suggest any remedial measures to be adopted for the general abatement of this pest in a given region. Very little can be said regarding protective measures. To kill the flies, as we instinctively do the mosquitoes, by a slap of the hand, is of no avail against the Hippelates, because they are too numerous and for other obvious reasons.

A close-fitting veil would no doubt protect the eyes, but in the hot days of a southern summer the wearing of a veil is a torture almost equal to that of the flies. For the same reason applications of oil of tar, oil of pennyroyal, and similar substances, which are more or less satisfactorily used in the North against the mosquitoes, black flies, and sand flies, is hardly bearable in the South. Smoking cigars or a pipe offers a good protection to those who indulge in this vice, but even an inveterate smoker can not smoke constantly when he is out of doors. A good smudge also drives away the flies, but of course can not be classed among the remedies that are handy and available at every hour and at every place. Sprinkling the coat collar and other parts of the clothing with Eucalyptus oil (and no doubt, also, other strongly smelling etheric oils), as lately recommended as a good repellent against house flies, should be tried, and promises, in my opinion, good results.

This sketch of the flies is naturally very incomplete, as, were the attempt made to include all that may at times annoy domestic animals, it would require a volume by itself. The common house fly, for instance, may often prove a serious pest to domestic animals, and its annoyance in houses is too well known to need any comment. The effort has been to give a fairly adequate treatment of those species which are of greatest concern to the stock raiser, especially in the United States.

Family HIPPOBOSCIDÆ.

(Forest Flies, Ticks.)

This remarkable and interesting group of insects contains two species of special interest to the stock breeder, both of which are old and familar pests.

The species of the family at large occur on a number of animals, but the greater number occur on birds, and especially upon birds of prey, and therefore have no relation to our present discussion.

They are horny-bodied, flattened flies with tubular mouth parts fitted for suction, and having, except the sheep tick, well-developed wings. They are therefore somewhat migratory in their habits.

They are especially remarkable and abnormal in their method of reproduction, the eggs hatching and the larvæ developing within the body of the adult, so that when extruded they have almost reached the pupa stage. The extruded larva changes almost immediately to the pupa, the larval skin forming a hard pupa case, and in this condition they resemble seeds. This stage is quickly passed, and the adult appears, assuming at once its mature form.

Williston remarks that the genus Lipoptena is remarkable in that in the earlier state the flies have wings and live on birds, but later they seek quadrupeds, where they remain, and having no further use for their wings, they lose them. It must be inferred that the young flies issuing on mammals migrate by means of their wings to birds and later return to a mammal host.

It is commonly stated that these flies produce but one or two young, but Dr. Curtice is authority for the statement that the sheep tick may produce from five to eight young, one after another, which would make the multiplication more rapid, and better account for the occasional abundance of this pest.

THE BIRD TICKS.

The species occurring on birds are included in the genera *Olfersia* and *Ornithomyia*, the former being distinguished by the absence of ocelli and the presence of two teeth under each claw.

Olfersia americana Leach is a rather common species on owls and other raptorial birds and also the partridge or ruffed grouse. It is described and figured by Packard as *Hippobosca bubonis*, in the Guide, p. 433.

O. albipennis occurs somewhat commonly on herons, and *ardeæ* is recorded from the same class of birds. Other species listed by Osten Sacken are *brunnea*, *mexicana*, *propinqua*, and *sulcifrons*.

Ornithomyia contains eight species, of which *nebulosa* is recorded from an owl, *Strix nebulosa;* and *pallida* Say from *Sylvia sialis*.

THE DEER TICK.

(*Lipoptena depressa* Say.)

This interesting form was described by Say from specimens taken from the common deer (*Cervus virginianus*). It is wingless, as usually found on this host, but according to Williston is provided with wings and occurs on birds during the early period of its existence. At this time the wings are weak, the veins slender.

THE FOREST FLY OR HORSE TICK.

(*Hippobosca equina* Linn.)

Linnæus described this species in 1761, but it must have been a familiar form to observers of insects long prior to that date. Since then it has received frequent notice, and mention of it occurs in numerous general works and in all treatises on Diptera or on the parasites of the horse.

Its injuries consist in the irritation produced by the movements among the hairs, their punctures of the skin, and loss of blood occasioned when occurring in numbers.

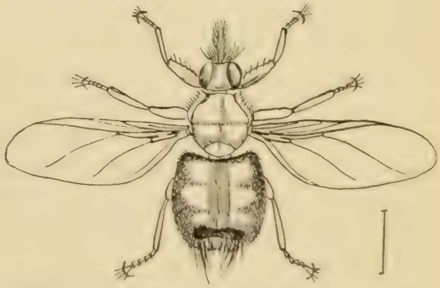

FIG. 73.—*Hippobosca equina* (copied from Packard).

It would seem to be far less common in this country than in the Old World, and I have yet to hear of a case where it has occurred in serious numbers. It is listed by Osten Sacken, on authority of Kirby and Loew.

It is of course possible that the species may multiply so as to become a pest, and this possibility should be recognized. It might, from the ability to fly, be more difficult to handle than the sheep tick, but doubtless the careful grooming of horses affected would prevent undue increase. Dusting pyrethrum in the hair would be useful, and this could be resorted to with horses in pasture as well as those that are stabled.

THE SHEEP TICK.

(*Melophagus ovinus* Linn.)

Linnæus described this species in 1761 under the name of *Hippobosca ovinus*, but in the later division of this genus, which at first covered all the forms included in the family, this species was assigned to the genus Melophagus.

It differs from the other members of the family in never possessing wings. The head is small and sunken into the prothorax. The middle portion of the thorax is rather slender, contrasting with the development of this region in the winged forms.

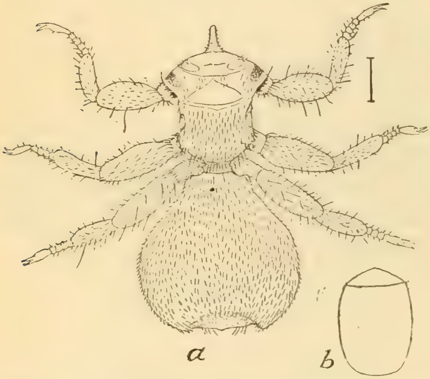

FIG. 74.—*Melophagus ovinus*: *a*, adult; *b*, puparium—enlarged (original).

It is of a reddish or gray brown color, about one-fourth of an inch long, and easily detected when present in any numbers on sheep. They never migrate from the original host except it be to attach to another animal of the same species, and probably the principal movement is that which occurs after sheep are sheared, when the ticks tend to migrate to lambs. On the sheep, if abundant, they may cause considerable damage, indicated by lack of growth or poor condition, and when massing upon lambs they may cause great damage, resulting in the death of the victims if not promptly relieved.

They are distributed over the world generally where sheep are kept, and are too well known by sheep breeders to make it necessary to emphasize the injury they may cause. All breeds of sheep seem alike subject to attack, but I know of no record of their occurrence upon other animals.

Curtice has determined that each female may produce from five to eight young, the seed-like brown puparia of which are often to be met with among the more numerous adults that adhere to the wool or skin.

REMEDIES.

While the ticks may be greatly lessened in number by the vigorous use of pyrethrum—a most available remedy during winter—the most practical plan to adopt, and one which if thoroughly followed will make all others unnecessary, is to dip the sheep each year after shearing.

Of the numerous dips which are in use, and which are discussed more fully in the chapter on remedies, the kerosene emulsion is recommended for this form, and several of the patented dips on the market are good, while tobacco dips, tar dips, etc., may be used, if preferred.

It is of course desirable to use a dip that will effectually destroy not only these ticks but the two forms of lice and the scab mites, in case any of these are present. A dipping tank is an essential part of the equipment for sheep raising, and its construction is described in the chapter on remedies.

A flock once freed from the pests will not be again infested except by the introduction of infested animals; hence care should be taken in making additions to the flock to free the newcomers from parasites. It is also well to keep the sheep for a few days after dipping in a different inclosure from what they occupied before, to avoid possible infestation from any stragglers that may have been caught on wool upon posts or brush, and if the wool is charged with them when clipped it should be stored where the ticks could not easily return to the sheep. The ticks can not travel any distance independently, and will soon die when removed from the sheep, but proper care here will assure success. With due care to have an efficient dip one operation should suffice, but it is a good plan to examine the herd a week or ten days after dipping, and if any parasites are found to have escaped, or to have issued from pupæ that survived, to repeat the operation.

A BAT HIPPOBOSCID.

Under the title of "A remarkable new hippoboscid from Mexico," Mr. C. H. T. Townsend describes a species which he names *Trichobius dugesii* and which he received from Dr. Dugès, of Guanajuato, Mexico, taken from a bat, *Glossophaga soricina*. (Entom. News, Vol. II, pp. 105–106, 1891.)

Family NYCTERIBIIDÆ.

(Bat Flies.)

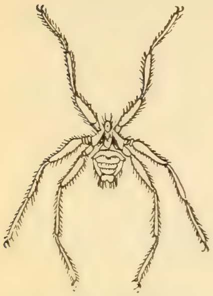

FIG. 75.—Nycteribia sp. (after Packard).

These very remarkable Diptera seem to have gone a step farther even than the Hippoboscidæ in their adaptation to parasitic life, the known forms being totally wingless and constantly confined to their hosts. The latter are various species of bats, and the species have been observed in various parts of the world, three only being recorded for this country, the *Strebla vespertilionis* Fab., credited to Jamaica, San Domingo, Cuba, and South America; the *Megistopoda pilatei*, from Cuba, and an unnamed species of Nycteribia, from California.

The *Strebla vespertilionis* is credited with occurring on pigeons and parrots, but considering the normal habits of all the known species these must be looked upon as stragglers.

CHAPTER III.

SIPHONAPTERA.

Fleas.

This group of insects, including the well-known fleas, has by many writers been considered as related to the Diptera, but in most recent works on systematic entomology it is given separate rank under the above name. It is unnecessary here to discuss the question of their zoological position, but it may not be out of place to remark that, while they are a very distinct group and doubtless well deserve to have this distinction indicated systematically, there is much to indicate that they have had a remote relationship to the dipterous branch. This is shown not only in the mouth parts and feet of the adults, but in the larvæ, which are footless, slender, worm-like creatures.

The insects of this group are characterized by the entire absence of wings, by having the bodies compressed, the legs long and stout, the coxæ being remarkably developed, giving them great leaping power. The mouth parts are well developed and adapted for suction, all the species in the adult stage feeding upon the blood of mammals or birds. The antennæ are small, usually sunken in a pit or groove in the side of the head and of peculiar form, the third, or terminal, segment being annulated, or, in some cases, even divided into leaf-like plates. The eyes are simple when present, but in many cases they are reduced to mere rudiments or even completely wanting. The tarsi are 5-jointed.

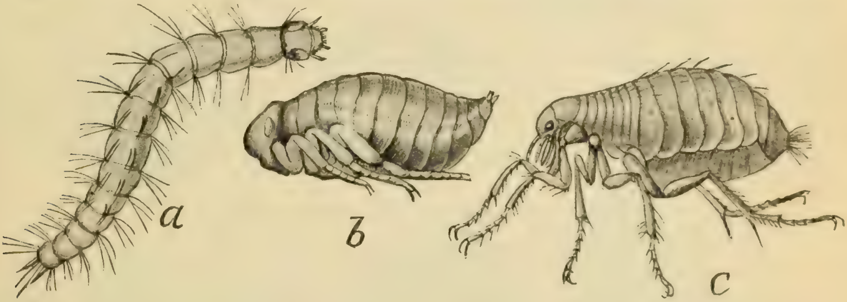

FIG. 76.—*Pulex irritans*: *a*, larva; *b*, pupa; *c*, imago—all enlarged (from Van Beneden).

They undergo a complete metamorphosis, the early stages being passed in places adjacent to the resorts of the host. The eggs, while sometimes laid upon the hairs of the host animal, are loosely attached and must ordinarily be scattered in places where the host forms sleep or nest. The larvæ, so far as known, live in dust or litter in similar locations. They are slender, worm-like, footless objects, with a sparse covering of hairs. The pupæ form in similar locations, inclosing themselves in cocoons. Westwood says:

> When full grown, which occurs in summer in about twelve days, the larvæ inclose themselves in a small cocoon of silk, often covered with dust, and attached to surrounding substances. Rösel, however, observed that some of the larvæ underwent their transformations without forming any cocoon.

In most of the available works the group is made to contain but a single family, the Pulicidæ, but more recent systematic works separate them into three families, the Sarcopsyllidæ, including the small forms, with large heads, which are confined to the host animal while in the gravid condition; the Vermipsyllidæ, in which the gravid females are not stationary, but the abdomen becomes swollen, and in which the labial palpi are 10-jointed; and the Pulicidæ, including most of our common forms, in which the female abdomen does not become swollen, and the labial palpi are from 3 to 5 jointed.

While the fleas are essentially parasitic in the adult stages, they are by no means so strictly confined to the host as are the Pediculidæ or most of the Mallophaga, but wander from the host at times, and may even be found on different species of animals than those which are evidently their normal hosts. Probably these stragglers do not, as a rule, maintain a permanent habitat upon the new host, and therefore, with the exception of one or two species, little attention need be given to prevention of migration or of transfer from one animal to another.

In the further discussion of species, which will be limited mostly to the American forms of economic interest, we will disregard these divisions and treat the species simply under their respective genera.

THE JIGGER FLEA, OR CHIGOE.

(*Sarcopsylla penetrans* Linn.)

Linnæus described this species more than a century ago (1767) under the name of *Pulex penetrans*, and it has been treated in many different works since that time. The various names of "jigger," "jigger flea," "chigoe," and "chique," applied to it in various localities, are evidently, in part at least, associated with its annoying habit. In distribution it covers all of tropical and subtropical America. Baker says "this flea is undoubtedly found throughout the tropical and subtropical regions of both hemispheres."

Railliet states that it was introduced into Africa about the year 1872, and that it has propagated there with astonishing rapidity.

While most of the records of its injuries have been with reference to its occurrence on man, it is a notable pest of inferior animals, and doubtless occurs much more frequently as a parasite of some of these than of man.

The dog and cat are among the species that are specially subject to its attack, but other mammalia are affected, and Railliet mentions sheep, goats, cattle, horses, asses, and mules, and even birds as hosts, and cites particularly a case where a hog was very seriously infested. The foot examined by R. Blanchard had been obtained from Liberia by J. Jullien, and after the extirpation of the fleas presented the appearance of the cells of honeycomb, so thickly had the parasites been crowded together.

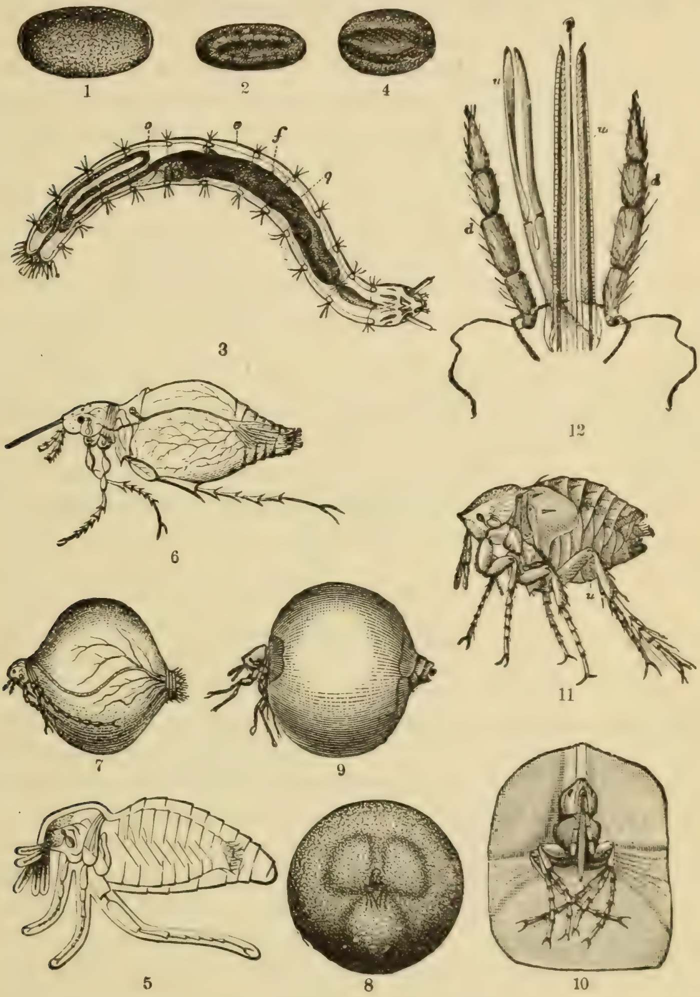

FIG. 77.—*Sarcopsylla penetrans:* 1, egg; 2, embryo; 3, larva; 4, cocoon; 5, pupa; 6, fecundated female; 7, the same on the third day from its entrance under the skin of its human host; 8, the same after several days' residence in the skin of its host; 9, fully grown female—magnified four times; 10, head of same still more enlarged; 11, female before entering skin; 12, mouth parts much enlarged: *m* mandibles, *d*, maxillary palpi, *u*, labium (after Karsten and Guyon.)

The adult fleas affect their hosts as in other species, but the females after impregnation burrow into the skin of the host, especially under the toe nails, and produce a swelling and later a distinct ulcer, sometimes so serious as to result fatally. With the development of the eggs the body of the female becomes greatly distended, so as to lose all semblance to the original insect, the head and legs appearing as little appendages upon a large round body the size of a pea.

The larvæ must normally escape from the body of the adult and issue from the opening of the tumor to undergo development after the ordinary habit of their relatives, but the crushing of the body of the adult in the tumor may result in their liberation in the tissues surrounding the body of the adult, and if they are not promptly expelled from the sore they may increase the injury caused by the adult.

The remedy most recommended is the extraction of the female as soon as the presence of a swelling or tumor indicates the presence of the parasite. This is accomplished by the introduction of a sharp knife point, the effort being to withdraw the insect entire, as the bursting of the body and discharge of the eggs in the sore is likely to result seriously.

For the prevention of the attacks upon domestic animals it would seem that attention to the infested animals and the destruction of the adults whenever detected, along with the liberal use of pyrethrum in the localities where the larvæ develop, would be of some service, though it can easily be seen that an insect with so large a number of hosts stands a very good chance of survival.

THE HEN FLEA.

(*Sarcopsylla gallinacea* Westw.)

Westwood[1] described this species from specimens brought by the famous Challenger expedition from Ceylon and collected by Mr. H. N. Mosely from the domestic hen. Taschenberg[2] gives his acccount of it from type examples in the collection of Dr. Ritzema Bos. The first record of its occurrence in America is a note in the Proceedings of the Entomological Society of Washington[3] upon specimens from Gainesville, Fla., sent to the society by Judge Lawrence C. Johnson, who later[4] presented the society with an account of the habits of the insect. These specimens were identified by Dr. A. S. Packard,[5] who also presents a review of the history of the species.

Baker[6] infers its occurrence in Texas from an account of injury to fowls reported in Bulletin 30, Texas Experiment Station, and records it from specimens furnished by the Division of Entomology from Florida; Floresville, Tex.; Hockley, Tex.; and Meridian, Miss.

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[1] The Entomologists' Monthly Magazine, Vol. XI, p. 246 (1874–75).

[2] Die Flöhe, p. 55, Pl. I, figs. 5, 5*a*.

[3] Vol. I, p. 59.

[4] Loc. cit., pp. 203–205.

[5] Insect Life, Vol. VII, pp. 23–24.

[6] Canadian Entomologist, Vol. XXVII, pp. 19, 111.

Packard mentions receiving specimens from Dr. Wagner, of St. Petersburg, labeled "Strix sp., Murgab, Suiran-Beir, 3, v, 1893," and calling attention to this widely different host suggests that the species has been carried from one region to another by means of birds.

From what has so far appeared it would seem that this pest is likely to become a very important one, at least through tropical and subtropical regions.

This species differs from *penetrans* in having the hind angles of the metathoracic scales angled instead of rounded and the eyes and antennæ in the posterior half of the head. It is from 1 to 1½ millimeters in length. But little is known as to its life history, and the following observations by Judge Johnson include all that I have met with in regard to this phase of the subject and methods of treatment:

"Like all fleas, it abounds mostly in shady places, under old houses, on earthen floors, and in all dusty, untidy spots. Hence from analogy when some years ago my attention was called to the subject by poultry breeders, I advised to have all such places closed up, and to deprive the fowls of all shade except such places as could be rained upon. Those who acted upon this advice were rewarded. Losses from this cause were reduced to a minimum. It was also seen that animals frequenting wet spots in summer were exempt from the pests.

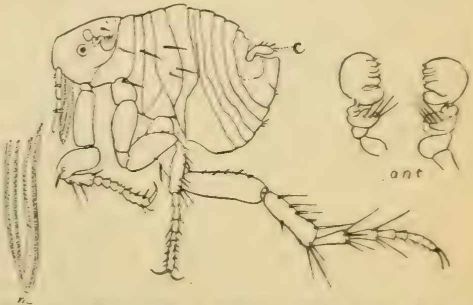

Fig. 76.—*Sarcopsylla gallinacea*: male, enlarged. *ant*, antennæ; *m*, palpi, more enlarged (from Insect Life, drawn by Packard).

"First observed to infest young animals, such as chickens, turkeys, kittens, puppies, and even calves and colts and children. I proposed for it the name of *Pulex pallulorum;* but whilst it is true the young suffer most, because possibly less able to defend themselves, it is by no means confined to them.

"In general appearance, size, color, and form greatly resembling a flea, popular observation notices one considerable difference—it does not hop. Closely examined, we find the femoral portion of the third pair of legs but slightly developed. Hence its motions resemble more the crawling of a wingless fly than that of our well-known active jumper.

"In its habits of feeding it differs from the ordinary flea. Instead of making an incision at which to lap blood, and from which it may quickly remove to another spot, our Florida variety plants itself where it intends to stay, like a tick. As to the males I can not say. Much of my information is second hand. The notion that these do not bite, which prevails with some persons, or at least that they do not stick, may be an error. Of the females, however, it is certain that they bury themselves in the skin of their victims. From the first they hold on with such tenacity that no ordinary brushing will remove them. It seems to be at this stage in their existence that impregnation takes place. The males now are often seen in copula with them, and so remain apparently for days, or until the tumefaction of the skin excited by the embedded female closes around her so as to shove him off. Here ends about all actually known of this history. From analogy we may infer that the period of gestation being completed, the gravid female lays her eggs in this well-prepared nidus, or, more particularly, that they remain and are hatched in her distended stomach, after which they crawl out and drop to the ground. If in a dry, shady spot, they undergo transformation to the perfect form; if in a wet spot or in the sun, they perish.

"Upon man I have never heard of the process continuing to the end. The itching caused by it generally attracts attention sufficiently to have the intruder hunted out. With the lower animals it is different, most notably with chickens. Spots bare of feathers, or nearly so, are selected in preference. A small knot resembling a wart grows over the insect, and so numerous and large at times as to spread over the eyes and into the jaws, and, blind and famished, the victim dies. In cases not fatal, after a month or two these knots or warts drop off, leaving a scar resembling a burn. With very young chickens or puppies death generally comes in the first stage, when every portion of their bodies is covered with innumerable enemies."

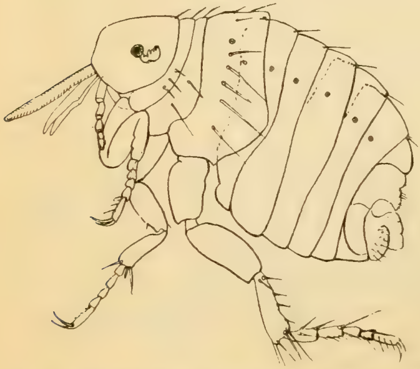

FIG. 77.—*Sarcopsylla gallinacea:* female—enlarged (Insect Life, drawn by Packard).

While some portions of this account would seem to refer to the chigoe or *Sarcopsylla penetrans*, especially that portion referring to the attacks upon man and other mammals, it no doubt includes about all that is known regarding the actions of this pest, and no one, probably, is better acquainted with the habits of the insect. There is also opportunity for confusion with the work of some of the Sarcoptes infesting fowls in cases where the observer cited was unable to make personal investigations.

OPOSSUM FLEA.

(*Pulex simulans* Baker.)

This species, described from the opossum, is said to be closely related to *irritans* and distinguished from it by the mandibles and hypopharynx being very short, not reaching one-half the length of the anterior coxæ,

THE HOUSE FLEA.

(*Pulex irritans* Linn.)

This, perhaps the best known species of flea, was described by Linnæus in 1746. It is distributed widely over the globe, and often becomes a serious pest in houses, sometimes even in spite of the most careful attention and cleanliness.

It is easily distinguished from the common flea affecting dogs and cats, and which is almost as frequent an inhabitant of houses, by the fact that there are no combs of spines upon the borders of the head or pronotum. From the much less common species just mentioned which occurs on the opossum, and which is most nearly allied to it, it is to be separated by the greater length of the mandibles and hypopharynx, which reach more than halfway the length of the anterior coxæ, by the the single row of bristles on each abdominal segment, the large male claspers, and the dark-reddish or piceous color.

The habits and life history of this species have long been known and frequently described. They occur particularly in houses, secreting themselves in bedding and clothing, and, especially at night, make their attacks on their human victims for the purpose of drawing blood.

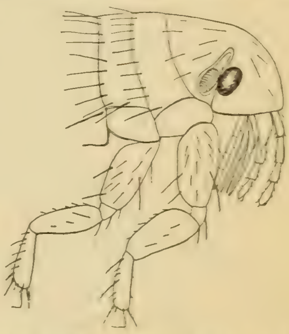

FIG. 80.—*Pulex irritans:* head and pronotum showing form and absence of combs (original).

Their eggs are deposited in out-of-the-way places, in the dust or lint under carpets, and the larvæ are said to feed upon the particles of organic matter which may be found in such localities.

Railliet states that each female deposits 8 to 12 eggs, which are whitish and ovoid and 0.7 mm. long by 0.4 mm. thick; further, that in summer the larvæ issue in four to six days, become pupæ eleven days later, and after about twelve days in this stage become adult; the time for development from egg to adult being, therefore, about four weeks, while in winter, in a warmed room, it occupies about six weeks.

While no amount of personal cleanliness will protect an individual from their attacks in a building which is infested by them, careful attention to the removal of all dust and refuse which may harbor the larvæ will assist in keeping them in check. The use of pyrethrum is very effectual in destroying them, and may be dusted in places which harbor them. (See also remarks under "The Dog and Cat Flea.")

THE BIRD FLEA.

(*Pulex avium* Tasch.)

According to Taschenberg, the common fleas, affecting a great variety of birds, including the domestic fowls, are all representatives of a single species, and although some of the forms were described as early as 1832 to 1835 he brings them all together, and, discarding the various names referring to particular hosts, as *gallinæ* Bouché, *columbæ* Gervais, *hirundinis* Sam., *sturni* Dale, and *fringillæ* Walk., proposes a new name, *avium*, to stand for the species.

It belongs to the series with no comb of spines on the head, but with a comb on the pronotum. The mandibles are short, not reaching to the ends of the anterior coxæ, and there are 24 to 26 spines in the pronotal comb. The hind femora have a row of minute bristles on the side, and the first two of the abdominal segments have minute teeth on the disk above. Length, 3 to 3½ mm. Dark brown in color.

The Rat and Mouse Flea.

(*Pulex fasciatus* Bosc d'Antic.)

This species seems to have received pretty general recognition, and has been recorded from quite a number of different hosts. Whether it can be said to be primarily a parasite of the rat and mouse I do not pretend to say, but since it has been noted a number of times from these animals, and so far only from these in this country, I have assigned it here.

Nothing has been recorded regarding its life history, but doubtless it is like its congeners.

The adults are elongate, with the head evenly rounded in front, without any comb of spines on the lower border, while the hind border of the pronotum bears a comb of strong spines, 18 in number. The mouth parts are of normal length, not extending beyond the anterior coxæ, a character which will separate it from its nearest allies, the *sciurorum* and *avium*. Taschenberg has collected a list of the known hosts, and enumerates Myoxus, *Cricetus frumentarius*, *Mus musculus* (mouse), *Mus decumanus* (rat), and *Canis lagopus;* and adds that he has also two examples from the Mammoth Cave, Kentucky. I have collected it from *Mus decumanus* at Ames, Iowa, which appears to be the only record from a definite host in America, but it is doubtless of common occurrence.

Squirrel Fleas.

Several species of fleas have been described from the squirrels, and while they do not occur indiscriminately on all species it will serve our purpose here to consider them together, referring for full description to the technical papers of Taschenberg and Baker.

Pulex sciurorum Bouché, the flea which infests squirrels in Europe, has not been found to occur on our American species of squirrels.

Pulex howardi Baker, recorded from the red squirrel, Ithaca, N. Y., "squirrel," Tallula Falls, Ga., gray or fox squirrel and nest of field mouse, Lincoln, Nebr., is apparently the most generally distributed of the American species.

There are no spines upon the head, but a comb of 18 spines is on the pronotum. The male claspers are armed with short, black teeth which very readily separate this species from its nearest allies.

Specimens from fox squirrel, Caddo, Ind. T., sent to me by Prof. W. W. Cooke, probably belong to this species, as Baker mentions several specimens in my collection without host, and as several of these specimens were sent him the labels of which may have been lost. The specimens being remounted I can not positively recognize them now.

Baker also describes *Pulex wickhami* from the flying squirrel (*Sciuropterus volans*), at Iowa City; *Pulex gillettei* from the red squirrel (*Sciurus canadensis*), Portland, Mich.; *Pulex coloradensis* from Fremont's chickaree, Georgetown, Colo.; *Pulex hirsutus*, from prairie dog (*Cynomys ludovicianus*), Stove Prairie, Larimer County, Colo.; *P. longispinus*, from Fremont's chickaree, Colorado, and *Pulex montanus*, from the large gray squirrel (*Sciurus alberti*), foothills west of Fort Collins, Colo.

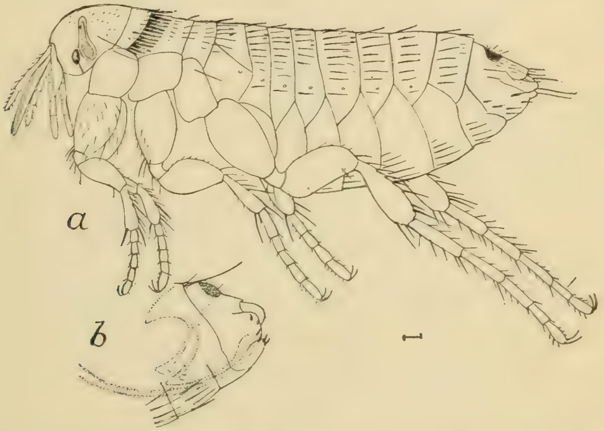

FIG. 81.—*Pulex howardi: a*, female; *b*, genitalia of male—greatly enlarged (original).

THE SPERMOPHILE FLEA.

(*Pulex bruneri* Baker.)

The common spermophiles, *Spermophilus 13-lineatus* and *S. franklini*, are very commonly infested with a large reddish-brown flea which has been recorded so far from Lincoln, Nebr., and Fort Collins, Colo., as well as Ames, Iowa, where I have taken it frequently during a number of years past.

The head is without spines beneath, but the pronotum bears a comb of about 16 spines. Baker describes it as follows:

> Apical spines on joint 2 of hind tarsi long as joints 3 and 4 together; antennal groove in middle of head; maxillary palpi in female with joint 2 three-fourths of 4, and 3 two-thirds of 4, labial palpi reaching to one-third of anterior femora; pronotal comb of 16 spines; in anterior tarsi joint 2 longer than 1 and one-third longer than 3; in middle tarsi joint 1 equals 3 and 4 together and shorter than 5, while 5 is

twice 4; in posterior tarsi joint 1 equals 2 and 3 together, 5 a little longer than 3 and less than one-half of 1, while 2 is three times 4 and less than 4 and 5 together; hind femora with a row of bristles on the side; color, light reddish brown, darker dorsally on the abdomen; length, 2 to 2.5 mm.

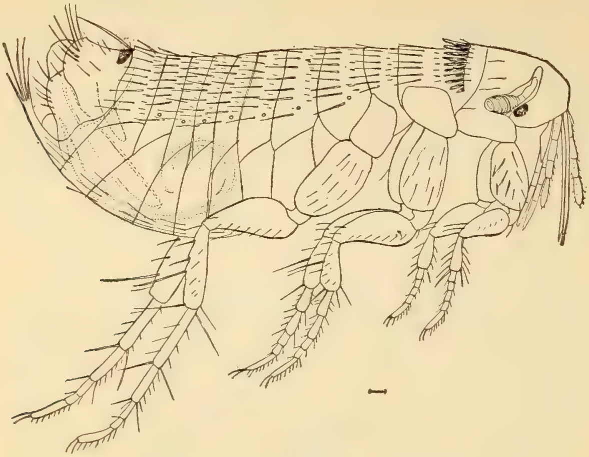

FIG. 82.—*Pulex bruneri:* male—enlarged (original).

While this species has been noted as so common on its ordinary hosts it has never been observed as occurring upon any of the domestic animals.

THE DOG AND CAT FLEA.

(*Pulex serraticeps* Gerv.)

The common flea, affecting the dog and cat, was described by Dugès[1] under the name of *Pulex canis* in 1832, and by Bouché[2] under the name of *Pulex felis* in 1835, these names referring to the forms infesting the dog and the cat, respectively. The reference of the two to one species under the above name by Gervais[3] was made in 1844.

It is one of the most abundant species known, and is distributed practically over the entire world. As a house pest it rivals the *irritans*, and in many places even seems to be about the only species occurring. Howard states that from the specimens sent to the Division of Entomology it is this species rather than *irritans* that is usually troublesome.

It may be easily distinguished from that species by the presence of the combs of spines on the border of the head and pronotum, those on the head being usually 6 to 9 in number and those on the hind border of the pronotum 14 to 18 in number.

The adults seem to adhere quite closely to their hosts, as cats and dogs infested by them will be found to carry them quite constantly, and their eggs may be found adhering very loosely to the hairs of these animals. They drop off, however, at the slightest touch, and must therefore be distributed in a great variety of places besides the sleeping places of their hosts, which would naturally receive the greater number. Dr. Howard suggests that for experimenters who may wish to follow out for themselves the life history of the species an easy way to collect the eggs is to lay a strip of cloth or carpet for the animal to lie and sleep upon, and afterwards to brush the cloth into a receptacle, in which the eggs will be found in numbers if the animal is infested.

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[1] Ann. des Sciences Naturelles, Vol. XXVII, p. 157.

[2] Nov. Act. Acad. Leop. Carol., Vol. XVII, i, p. 505.

[3] Hist. Nat. des Ins. Apt., Vol. III, p. 371.

Verrill gives the following condensed account of the life history of this species:

> The female cat flea lays her eggs among the fur of the cat, to which they are but slightly attached. These eggs are very small, white, and long oval. As the cat walks or runs about, the eggs are constantly being scattered around, often in great numbers. On one occasion I was able to collect fully a teaspoonful of these eggs from the dress of a lady in whose lap a half-grown kitten had been held for a short time. The places where cats sleep become well filled with eggs. These hatch in about two weeks into little, white, footless, maggot-like larvæ, which have small tufts of hairs along the sides. They are at first about one-sixteenth of an inch long. The head is pale yellow and the posterior end of the body bears two spines. These larvæ feed upon decaying particles of animal and vegetable matter always to be found in the dirt where they live. They move about by means of their hairs and spines. They grow rapidly in warm weather, and in about twelve days, when they mature, spin a slight silken cocoon and change to a pupa, which is inactive. This looks more like the mature flea and has the legs free. In a short time, varying from ten to sixteen days or more, according to the temperature, the pupa matures, and the full-formed flea comes forth from the cocoon, ready and willing to take care of itself. * * * They pass the winter both in the mature and larval states, and perhaps also as eggs and pupæ. There are several broods each season.

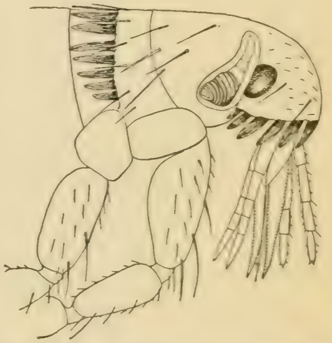

FIG. 83.—*Pulex serraticeps:* front part of body, showing combs on head and pronotum—enlarged (original).

REMEDIES.

A very concise statement of the remedies to be applied for fleas is given in circular No. 13, by Dr. L. O. Howard:

> The larvæ of the dog and cat flea will not develop successfully in situations where they are likely to be disturbed. The use of carpets and straw mattings, in our opinion, favors their development, since the young larvæ can penetrate the interstices of either sort of floor covering and find an abiding place in some crack where they are not likely to be disturbed. It is comparatively easy to destroy the insect in its early stages (when it is noticed), as is shown by the difficulty of rearing it, but the adult fleas are so active and so hardy that they successfully resist any but the most strenuous measures. Even the persistent use of California buhach and other pyrethrum powders was ineffectual in one case of extreme infestation, as was also, and more remarkably, a free sprinkling of floor mattings with benzine. In this instance it was finally necessary to take up the floor coverings and wash the

floors down with hot soapsuds in order to secure relief from the flea plague. In another case, however, a single liberal application of buhach was perfectly successful, while in a third a single thorough application of benzine completely rid an infested house of fleas.

To sum up: Every house where a pet dog or cat is kept may become seriously infested with fleas if the proper conditions of moisture and freedom from disturbance exist. Infestation, however, is not likely to occur if the (bare) floors can be frequently and thoroughly swept. When an outbreak of fleas comes, however, the easiest remedy to apply is a free sprinkling of pyrethrum powder in the infested rooms. This failing, benzine may be tried, a thorough spraying of carpets and floors being undertaken, with the exercise of due precaution in seeing that no lights or fires are in the house at the time of the application, or for some hours afterwards. Finally, if the plague is not thus abated, all floor coverings must be removed and the floors washed with hot soapsuds. This is a useful precaution to take in any house which it is proposed to close for the summer, since even a thorough sweeping may leave behind some few flea eggs from which an all-pervading swarm may develop before the house is reopened. * * *

Provide a rug for the cat or the dog to sleep on and give this rug a frequent shaking and brushing, afterwards sweeping up and burning the dust thus removed. As all the flea eggs on an infested animal will not, however, drop off in this way, and those which remain on it will probably develop successfully, it will be found wise to occasionally rub into the hair of the dog or cat a quantity of pyrethrum powder. If thoroughly applied, it will cause the fleas to fall off in a half stupefied condition, when they, too, may be swept up and burned.

In the observations made at this Department upon this species of flea during the summer of 1895, some difficulty was found in preserving just the right degree of moisture to enable the insect successfully to transform. An excess of moisture was found prejudicial to the development of the species, as was too great dryness. The observations showed, however, that at Washington in summer an entire generation may develop in a little more than a fortnight. Hence a housekeeper shutting up her house in June, for example, with a colony of fleas too small to be noticed inside it need not be surprised to find the establishment overrun when she opens it up again in September or October.

Rabbit Fleas.

The different kinds of rabbits are very abundantly supplied with fleas, as doubtless any one who has handled these animals will willingly testify. According to authorities, however, there are at least three different species of fleas which may infest them. The species infesting the European hares is known as *Pulex goniocephalus* Tasch., and this has not as yet been recognized in America. *Pulex gigas* of Kirby was originally described from Canada, and Baker has recorded it from the cottontail rabbit, at Lansing, Mich. It is described as having the head rather evenly rounded in front, the eyes in the anterior half of the head, mandibles reaching two-thirds of the coxæ, the comb on the border of the head of one or two spines, pronotal comb of 20 spines, light reddish-brown, the female 4 mm. long.

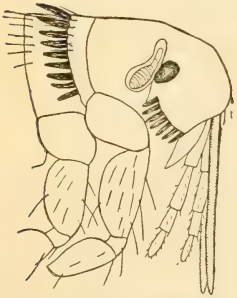

Fig. 84.—*Pulex inaequalis*—head and forepart of body—enlarged (original).

Pulex inaequalis Baker, described from cottontail and jack rabbits near the Grand Canyon, Arizona, is thought by Baker to be the North American representative of *goniocephalus*. It is distinguished from *gigas* by having the head obtusely angulated in front, the head spines 5 or 6 in number and pronotal spines 16. Length of the male, 1.5 mm.; female, 1.75 to 2.25 mm. A variety called *simplex* is indicated as having 8 spines in the head comb, 14 in the pronotal comb, and being slightly larger in size, 2.5 mm. in length. This variety seems to be the common form on *Lepus sylvaticus* in Iowa.

Pulex goniocephalus has sharply angulated forehead and pronotal comb of 14 spines. It has a length of 2 mm.

THE MOLE FLEA.

(*Typhlopsylla assimilis* Tasch.)

This species, described by Taschenberg from the European mole in 1880, appears to be identical with the species found on our common moles *Scalops aquaticus* and *argentatus*.

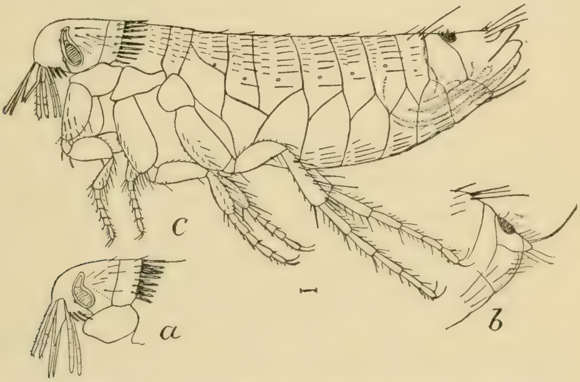

FIG. 85.—*Typhlopsylla assimilis: a* and *b*, head and terminal segment of female; *c*, male—enlarged (original).

The eye is very rudimentary, scarcely visible under the microscope, the head with a comb of 3 spines on the lower border and the pronotum with a comb of 7 to 9 spines on each side. "Male claspers boot-shaped, the sole turned up." Color rather dark brown, more intense along the dorsum. Length 2.5 mm.

It is recorded from *Sorex vulgaris*, *Talpa europea*, *Mus sylvaticus*, and *Arvicola arvalis* by Taschenberg, and Baker records it from the mole, Lincoln, Nebr., and the "common garden mole," Lansing, Mich. I have taken it repeatedly from the prairie mole (*Scalops argentatus*) at Ames, Iowa, and have specimens from Prof. A. W. Bitting from *Scalops aquaticus*, Lafayette, Ind.

From these records it would appear to be quite closely confined to the mole as its particular host, and the rudimentary nature of its eyes might be looked upon as a parallel adaptation with that of its host.

THE POCKET GOPHER FLEA.

(*Typhlopsylla americana* Baker; also *Pulex ignota* Baker.)

This species, described by Baker (Canadian Entomologist, Vol. XXVII, p. 186), I have taken repeatedly from our common pocket gopher (*Geomys bursarius*) during the past ten years, and it must be a common resident of their burrows. Mr. Baker records it from a "large brown mole," and states that he has seen specimens collected by Professor Gillette on the pocket gopher at Fort Collins, Colo., and by Professor Aldrich at Moscow, Idaho, on *Thomomys talpoides.*

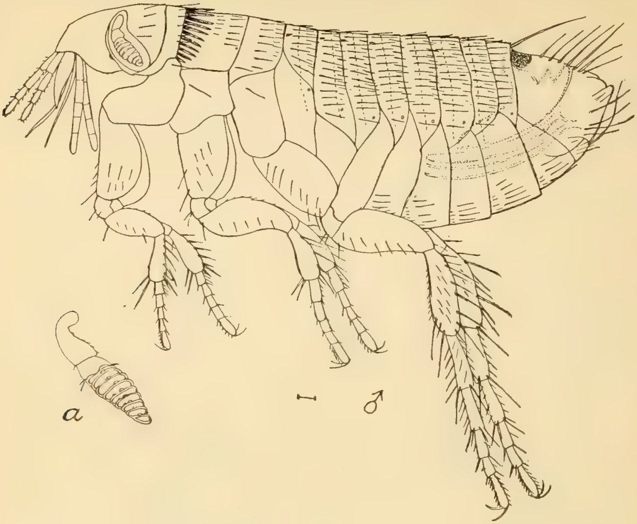

FIG. 86.—*Typhlopsylla americana:* male; *a*, antenna—enlarged (original).

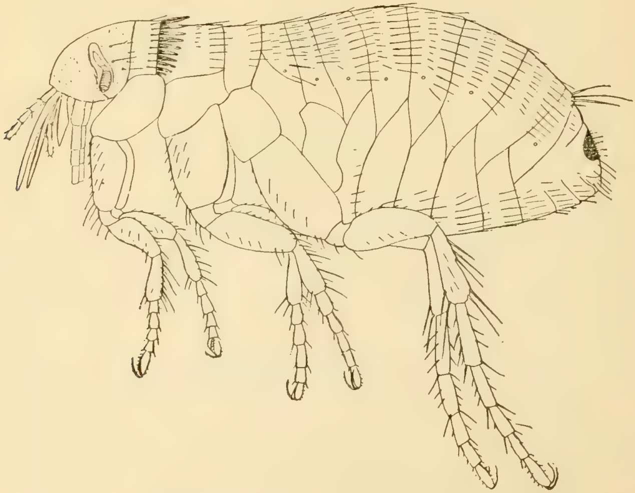

FIG. 87.—*Typhlopsylla americana:* female—enlarged (original).

Vertex evenly rounded from occiput to mouth, slightly flattened above in male; head with very weak bristles; bristles on joint 2 of antennæ longer than third joint, which is without bristles; mandibles attaining three-fourths of anterior coxæ; pronotal comb of 18 to 22 spines; legs with strong spines on tibiæ and hind tarsi; hind femora with a row of bristles on the side; in middle tarsi joint 2 is longer than 5; in hind tarsi joint 1 is about as long as 2 and 3 together, while 5 is shorter than 3; abdominal segments each with two dorsal and two ventral rows of numerous bristles, the second dorsal row with 12 to 14 bristles, the ventral row with nearly as many, ventral bristles not stronger than dorsal; male claspers long, linear, edges not parallel, end somewhat obliquely cut off, rounded; color, brown; length of male, 2.25 mm., of female 3 to 3.25 mm. (Baker.)

The form described as *Pulux ignota* by Baker is evidently a female of this species, and, since it appears to be a Typhlopsylla, the name *americana* had better be retained.

Aside from the species mentioned above in the genus Typhlopsylla, Kolenati has described *octactenus*, *hexactenus*, *pentactenus*, and *dictenus* occurring on bats in Europe, Taschenberg *unipectinata* on bat in Europe, *musculi* from rats and mice in Europe, *caucasica* on *Spalax typhlus* in the Caucasian Steppes, *gracilis* on *Talpa europea* and *Sorex vulgaris* in Europe, and Baker has described *alpina* from mountain rat, Georgetown, Colo., and *fraterna* from garden mole, Lansing, Mich., and Brookings, S. Dak, host unknown.

CHAPTER IV.

HEMIPTERA.

Bugs and Lice.

SUBORDER HETEROPTERA.

Insects with suctorial mouth parts; four wings, unless altogether wanting, the upper or front pair being thickened or leathery at the bases. The young resemble the adults except in size and in wanting wings. They live upon the juices of plants or animals, which they procure by suction.

Family ACANTHIIDÆ.

(Bed Bug and Allied Forms.)

THE COMMON BED BUG.

(*Acanthia lectularia* Linn.)

This species, described by Linnæus a century and a half ago, has been a most familiar insect to man, though for how long a time it is quite difficult to determine. Westwood (Introduction, Vol. II, p. 475) says:

> Its introduction into this country (England) has been a subject of discussion. It was well known to Pliny (Hist. N., 29, 17), Dioscorides, Arisrophanes, and Aristotle (Hist. An. Ed. Bek., p. 148, 12); but it has been generally asserted to have been brought from America to England, whence it passed to the Continent of Europe, and that it was not known here until 1670. Mouffet, however (Ins. Theatr., p. 270), mentions its having been seen in 15[illegible]3. It has, however, been noticed as a singular fact, and as showing that this disgusting visitant must have been comparatively little known in the days of "Good Queen Bess," that, although the word "bug" occurs five or six different times in Shakspeare's plays, it is in every instance synonymous with bugbear, and does not designate this insect (Patterson's Shakspeare Letters, p. 59).

It is by no means easy to estimate the amount of injury caused by this insect, for so far as man is concerned it consists of loss of time and comfort, while its effects upon other animals are involved in too much obscurity to allow of any estimates being formed.

As found in houses infesting man it can only be considered as semiparasitic, living for the most part secreted in cracks and crevices and attacking its victims during the night. Probably its attacks upon other animals are of a similar nature, although it is referred to by some authors as a parasite of domestic fowls.

The eggs are oval in shape, of a whitish color, slightly narrowed at one end, and will be found in great numbers in the cracks which furnish shelter for the adults. The young bugs escape from the eggs by pushing off a circular lid at one end. They are similar to the adults except in color and in the proportions of the body regions. At first nearly white, they gradually assume the reddish and finally the dark reddish brown color of the adults. The body is at first more slender and the head larger in proportion to the rest of the body, but gradually the abdomen widens until the insect acquires the shape and size indicated in the figure.

Professor Uhler says (Standard Natural History, Vol. II, p. 205):

> This species has been distributed over most parts of the world, chiefly by the agency of man, and, as might be expected under such circumstances, is subject to much variation in the relative size, proportions, and forms of most parts of the body. Full-favored gross specimens are often quite coarsely punctured and hairy, while their half-starved brethren have a much thinner outside integument and finer punctures, with less conspicuous pubescence. Some specimens have the wing pads hanging loose as if ready to change into wing covers, but generally these are run together into one piece on the middle line. Thus far no individuals of this insect have been met with fully winged.

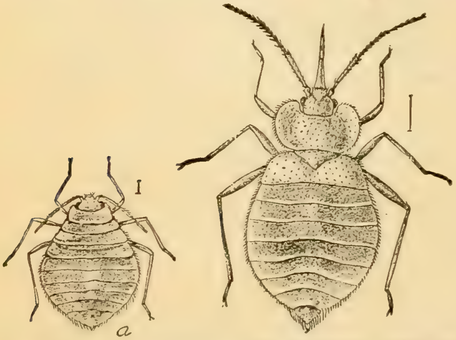

FIG. 88.—*Acanthia lectularia*: *a*, young; *b*, adult—enlarged (from Riley).

There is some confusion as concerns the attacks of the bedbug or its parasitism on other animals than man. Packard (Guide to the Study of Insects, p. 551) states that "it lives as a parasite on the domestic birds, such as the dove," and further, same book and page, that "Mr. James MacDonald writes me that he has found a nest of swallows on a court-house in Iowa swarming with bugs." In the American Entomologist (Vol. I, p. 87) the following statement occurs:

> Ordinarliy the bed-bug is confined to the dwelling places of man, and lives on the blood of us great lords of creation, but we have known it to swarm in prodigious numbers in a chicken house, where it must have fed exclusively upon chickens' blood, and it is said to occur also in European pigeon houses.

As other species of the same genus have been described as infesting pigeons, swallows, and bats, respectively, it might be that these statements are based upon observations which did not take into consideration the specific distinctions. Still another source of confusion exists so far as birds are concerned, and that is the occurrence upon the swift (*Chætura pelasgia*), frequently called "swallow" or "chimney swallow," a species of louse (*Nitzschia pulicaria*) which, though smaller, has so much of a resemblance to the bed-bug as to mislead an observer not familiar with the characters separating the divisions of insects to which these belong.

Whatever its foundation, there is a widespread belief that birds and bats carry bed-bugs from place to place, and considering the suddenness with which they appear in new buildings and sometimes in buildings never used for dwellings, it seems hard to otherwise account for their appearance. Still, to those familiar with the habits of the bed-bug and its opportunities for transportation, there will be no insuperable difficulty in accounting for all such appearances.

Another impression seems to be that bed-bugs occur in the woods and under bark. A footnote in Westwood's Introduction (Vol. II, p. 475) reads:

> Southall states that its first appearance took place after the great fire in 1666. "Learned men," says he, "united in thinking they were imported with the new deal timber, as the bugs were naturally fond of turpentine woods." It is certain that they swarm in the American timber employed in the construction of new houses; and it is said that they feed upon the sap of that wood.

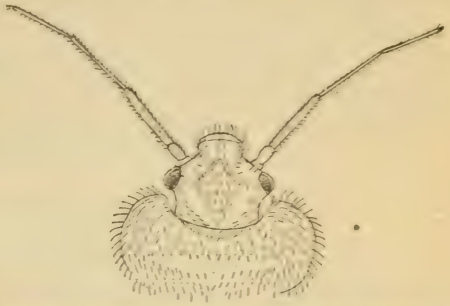

FIG. 89.—*Acanthia lectularia*: head and prothorax—much enlarged, showing form and clothing (original).

We fail to find, however, any authentic record of such occurrence from personal observation, and since we have never met it in collecting under the best conditions for observing it we are inclined to think that the impression is due entirely to other insects closely resembling the bed-bug having been mistaken for it. In 1839 Mr. Leonard Jenyns published a paper in the Annals of Natural History (Vol. 3, pp. 241–244) on three undescribed species of the genus Cimex, closely related to the common bed-bug (*C. columbarius*, *hirundinis*, *pipistrelli*). These are stated to infest, respectively, the pigeon, the swallow, and the bat. The occurrence of any of these but *hirundinis* has not yet been recorded in the United States, although, for reasons already stated, they might fail to be recorded even were they fairly common.

PREVENTION AND REMEDY.

Cleanliness and the application of the common remedies, such as benzine, corrosive sublimate, and hot water will usually suffice to keep these pests reduced in ordinary dwellings, but in large buildings more general measures may sometimes be necessary, and in such cases there is probably nothing more effectual, when it can be done, than thorough fumigation with sulphur, brimstone, or perhaps bisulphide of carbon. "I have known a house which had long stood empty, and yet swarmed with them, thoroughly cleansed by fumigation with brimstone" (Westwood).

We know personally of an instance where a large building, badly infested with this pest, on being thoroughly fumigated with sulphur as a disinfectant against scarlet fever remained for some time comparatively free from bugs.

Attention to the cracks in the walls and around casings, as well as to the joints of bedsteads, will do much to keep pests under control.

For immediate relief in a sleeping room pyrethrum is most available, since it can be used while a room is occupied. Dusted between the sheets of a bed, it will protect the sleeper from the most voracious hotel bug.

THE "CORUCO," OR MEXICAN CHICKEN BUG.

(*Acanthia inodora* Dugès.)

In 1892 Dr. Alfredo Dugès, of Guanajuata, Mexico, described[1] and figured a species of bed-bug infesting poultry, and the same, or a very closely related form, is recorded from southern New Mexico by Prof. C. H. Tyler Townsend, who says:

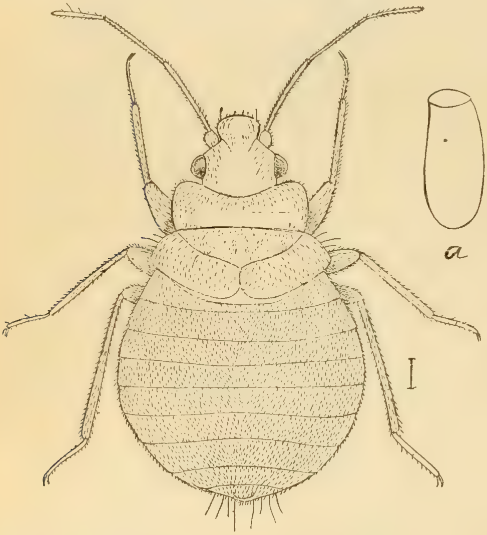

FIG. 90.—*Acanthia inodora*: female; *a*, outline of egg—enlarged (original).

> There exists in southern New Mexico a Cimicid, known by the Mexican name of coruco, which is an unmitigated pest of poultry in this region. When the insect once gains access to the henhouse it soon swarms in great numbers, infesting the inmates and roosts, and covering the eggs with the excrementa, which show as black specks. It is a very difficult pest to exterminate, and has been frequently known to spread from roosts to dwelling houses, where it proves more formidable than the bed-bug. This insect also exists in western Texas. * * *
>
> Dr. Dugès mentions applications of vinegar as a remedy, doubtless to be applied to the poultry to alleviate the bites, as well as to deter the corucos from biting. Here burning of sulphur in the henhouses and spraying of kerosene have been tried with doubtful results. About the only way to keep poultry uninfested is to keep them entirely out of doors and not to house them at all. The corucos infest and stick to the houses and roosts, awaiting the return of the hens at night. They began to appear in Las Cruces the present year (1893) before the middle of April.
>
> I am informed that the corucos often swarm in immense numbers in houses, coming up through the floors and cracks. In such cases it is almost impossible to get rid of them, the easiest and most economical way being to desert the house. They

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[1] La Naturaleza, 2d series, Vol. II, 1892, Pl. VIII, 8 figs.

have been known, according to one informant, to swarm in military posts in former times in southern New Mexico to such an extent that the soldiers were ordered out and formed in two lines, one line with brooms to sweep the corucos en masse up against an adobe wall, where the other line stood ready with trowels and mud and plastered them into the wall alive—a novel but effective means of riddance!

I have not seen Dr. Dugès's original article, but he has very kindly sent me specimens of the insect, and from these the accompanying drawing has been prepared. It will be seen that the form is quite distinct from that of the ordinary house bug, especially in the excavation of the prothorax in front, which is very slight, the lateral angles not projecting forward on the sides of the head.

THE BARN-SWALLOW BUG.

(*Acanthia hirundinis* Jenyns.)

This species has occurred in great numbers in the nests of the common barn swallow at Ames, Iowa, the occurrence being noted by Professor Gillette (Entomological News, Vol. I, pp. 26–27) and by the writer in the Canadian Entomologist, Vol. XXIV, p. 264.

The bugs appear to be confined to the swallow nests or upon the parts of the barn adjacent to them, some being observed on the sides of the barn nearly down to the ground. They were very abundant after the swallows had left in autumn, and specimens kept in a bottle corked with a rubber stopper were alive the following summer. It would be an easy matter for them to survive in the nests or in cracks and corners of the building near the nests during the winter absence of the hosts. The nests contained immense numbers of empty eggshells, showing that the eggs were deposited directly in the nests, and where the young bugs in hatching would at once gain access to the birds.

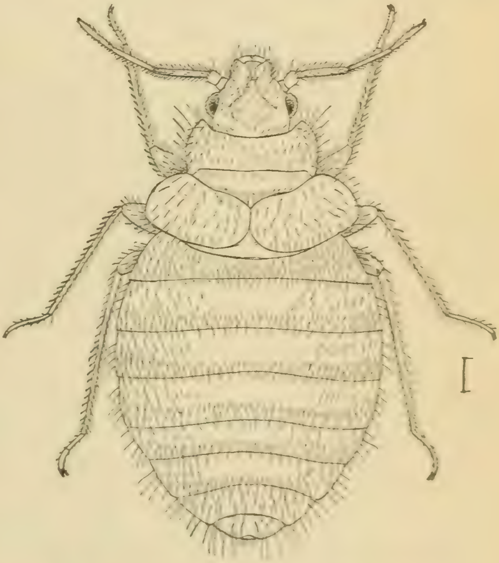

FIG. 91.—*Acanthia hirundinis*—enlarged (original).

While it is impossible to say at just what time the eggs were laid, it is safe to conjecture that they are laid some time during the early part of the summer, probably soon after the appearance of swallows in the spring, and that the young become partially grown at least before fall.

It is of course possible that they may use other food than the blood of the swallows, but it is evident that they are closely associated with this bird as a host. The figure will indicate the distinctive characters of the species, and comparison with the *lectularia* and *inodora* will reveal sufficient basis for considering it a distinct form.

The species occurring upon the pigeon and the bat have not been recorded for America so far as I am aware, but it is quite probable that they may occur. They are evidently quite distinct species, and it would be a matter of interest to determine their occurrence here.

Acanthia columbaria Jenyns is specially characterized by the rounded form of the abdomen, the slightly excavated prothorax, and the third joint of the antennæ being longer than the fourth.

Acanthia pipistrelli Jenyns has the abdomen narrowed, the prothorax moderately deeply excavated, the antennæ intermediate, between *lectularia* and *columbaria.*

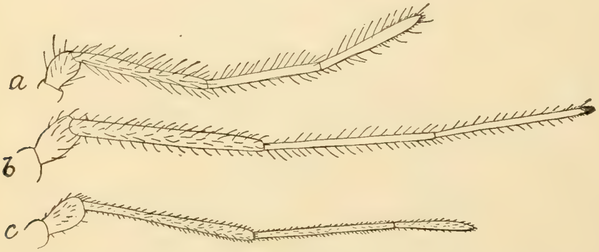

FIG. 92.—Antennæ, showing comparative length of joints in *a*, *Acanthia hirundinis; b*, *A. lectularia; c*, *A. inodora*—enlarged (original).

Considering the inaccessibility of the original descriptions to many students, it may be useful to repeat here the full technical descriptions as given by Jenyns (Annals of Natural History, 1839, Vol. III, pp. 241–244):

C. lectularius: Ferrugineo-ochraceus; thorace profunde emarginato, lateribus reflexis; abdomine suborbiculato, apice acuto; antennis articulo tertio quarto longiore. Long. 2¼ lin. Hab. In domibus.

C. columbarius: Ferrugineo-ochraceus; thorace profunde emarginato, lateribus reflexis; abdomine orbiculato, apice subacuto; antennis articulo tertio quarto paulo longiore. Long. vix 2¼ lin. Hab. In columbis.

C. hirundinis: Fusco-ferrugineus; thorace leviter emarginato, lateribus planis, abdomine ovato, apice subacuto; antennis brevibus, articulo tertio et quarto subaequalibus. Long. 1¾ lin. Hab. In nidis Hirundinis urbicæ.

C. pipistrelli: Ferrugineo-ochraceus, nitidus; thorace profunde emarginato, lateribus paulo reflexis; abdomine ovato, postice attenuato; antennis articulo tertio quarto longiore. Long. 2 lin. Hab. In Vespertilione pipistrello.

C. columbarius: On comparing this species with the common house bug it will be found to be smaller and of a more circular form. The antennæ are shorter and the joints are not quite so slender, and the difference in length between the third and fourth joints is not so considerable. The thorax is rather less hollowed out in front, the anterior angles less produced, and the sides less reflexed. The abdomen more nearly approaches the round, the lateral margins being very much curved and the greatest breadth exactly in the middle; whereas in the house bug the lateral margins are at first but little curved, and the greatest breadth rather behind the middle. The colors as well as the degree of the pubescence are similar in the two species.

C. hirundinis: This species is rather less than *C. columbarius* and in respect to form different from both this and the *C. lectularius.* The antennæ are comparatively short, and the third joint is scarcely if at all longer than the fourth. The eyes are not so prominent, the thorax is much less hollowed out in front, the anterior angles but little produced, and the sides scarcely at all reflexed. The scutellum is wider at the base or more transverse and does not project so far backward; the elytra are less coarsely punctured; the abdomen is not so broad, and more rounded at the apex, the sides regularly curved. The whole insect is more pubescent. The color is ferruginous, inclining to testaceous, darker than in the common bed-bug, and the head and thorax are much clouded with fuscous. In one specimen the legs are spotted at or near the joints with this last color. There are also some fuscous spots on the abdomen. The young or pupæ have the abdomen much narrower than the perfect insect, inclining to oblong.

C. pipistrelli: The antennæ of this species are of an intermediate length between those of the *C. lectularius* and those of the *C. columbarius,* and the third joint is obviously longer than the fourth. The eyes are prominent. The thorax has a moderately deep excavation in front, and the sides are partially reflexed. The abdomen is narrower than in either of the above-named species, and much more attenuated posteriorly, the greatest breadth being rather before the middle. The thighs are more incrassated. The whole insect is more pubescent, approaching to hispid, and rather coarsely punctured. The color is dark ferruginous ochre, glistening with a faint metallic or subaeneous hue, not perceptible in any of the other species. The legs and antennæ are a shade paler than the abdomen, and, as well as this last, without spots.

Family REDUVIIDÆ.

This family contains a large variety of bugs, the majority of which appear to be strictly carnivorous in habit, many of them being of no little service in destroying injurious insects. They are provided with stout curved beaks; the antennæ have the terminal joints smallest; the head is cylindrical, the neck usually long and the bodies generally slender, while the legs are strong and often armed with spines. Many species are capable of inflicting severe wounds, but probably very few of them do so except in self defense. One species, however, has been so many times recorded as attacking individuals of the human species for the purpose of sucking blood for food that it should be mentioned, at least, in this connection.

THE BLOOD-SUCKING CONE-NOSE.

(*Conorhinus sanguisuga* Lec.)

This species, sometimes called the "big bed-bug," is distributed throughout the southern United States and has been reported as frequently occurring in beds, attacking the sleepers and sucking their blood. The following from the American Entomologist (Vol. I, p. 88) sums up its habits:

> While taking his meal, as we are informed, he fairly spraddles himself out, and seems to enjoy it hugely. In the more southerly parts of Illinois, namely, in Madison, Jersey, and Union counties, we know of no less than eight specimens having been found in beds, and it must also occur as far north as Adams County, for we saw it in a collection of insects made at Quincy and exhibited at the State fair in 1868. Mr. Uhler, as he informs us, formerly received a specimen from southern Ohio, near Marietta, at which place it was said to be occasionally found in beds, and to cause

severe inflammation by its puncturing. Dr. E. S. Hull, of Alton, Ill., was once, as he tells us, bitten in three places in the arm by one of these creatures, and the arm became so inflamed in consequence that for three days afterwards he almost lost the use of it. In the northerly parts of the United States, so far as we are aware, it does not occur. Like many of its allies it passes the winter in the perfect state, for we have ourselves captured it in south Illinois under loose bark in November, in company with its pupa (fig. 93, *b*).

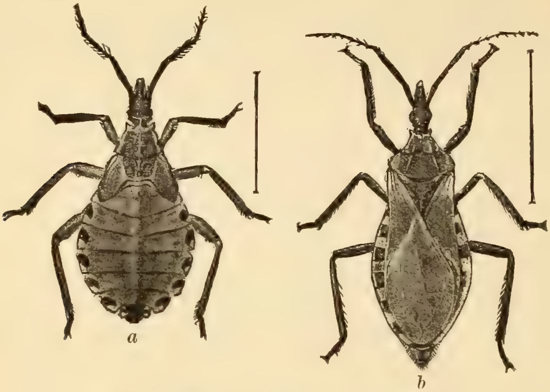

FIG. 93.—*Conorhinus sanguisuga: a*, pupa; *b*, adult (from Amer. Entom.).

All the species of this genus, most of which are South American, fly into houses by night, according to Burmeister, and live upon the blood of mammals, the puncture of their beaks causing great pain. In the larval and pupal states they probably suck the juices of insects; for being wingless in those states they would have no means of reaching the larger animals. The single pupa that we found under bark in winter time occurred in a place that was about half a mile from the nearest house; so that at all events it certainly could have had no chance there to suck human blood.

SUBORDER PARASITA.

This group includes the suctorial lice, confined to mammals; they are strictly parasitic insects, being confined to their hosts constantly and deriving all their nourishment from them. They are wingless, and the mouth parts consist of a tubular suctorial organ.

This suborder contains but two families, the first of which, the Polyctenidæ, contains, so far as known, but two species, both of which are confined to bats, one in Jamaica and the other in China. These do not properly fall within the province of this paper, and it will not be necessary to give them further consideration.

Family PEDICULIDÆ.

(The Suctorial Lice.)

This family includes nearly all the species of the suborder and all that come within the limits of this paper.

We need only add to the character above given the short rostrum without joint and the tarsi adapted to clasping and holding to hairs.

The eggs—"nits"—are attached to hairs by a glue-like substance, and the young lice when hatched resemble the adults except in size. As the entire life of the parasite is passed upon the same animal or on another animal of the same kind, its range of habit is easily stated.

But very few of the species are ever found upon any other species of animal than that which they normally infest, and if so always upon very nearly related species. Whether this is due to differences in the thickness of the skin, of temperature, of the size of the hair to which they must adhere and to which their feet are adapted, or to some subtle difference in the odor or taste peculiar to their particular host which leads them to discard all others, we are unable to say.

The mouth parts are necessarily capable of great extension in order to reach the blood of their hosts. Uhler says (Standard Nat. Hist., Vol. II, p. 209): "A fleshy unjointed rostrum, capable of great extension by being rolled inside out, this action serving to bring forward a chaplet of barbs which embed themselves in the skin to give a firm hold for the penetrating bristles, arranged as chitinous strips in a long, slender, flexible tube, terminated by four very minute lobes, which probe to the capillary vessels of a sweat pore. The blood being once reached a current is maintained by the pulsations of the pumping ventricle and the peristaltic movements of the stomach."

The species infesting man are so nearly related to the others that we can not well pass them by without notice.

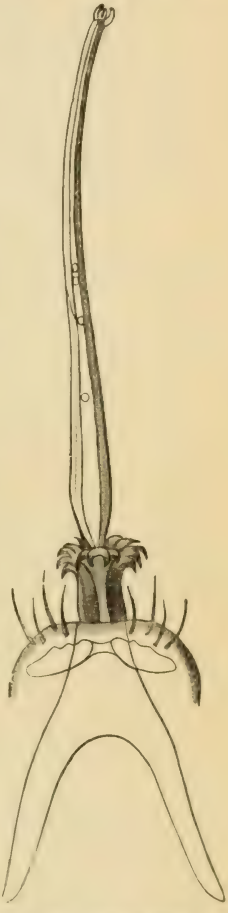

FIG. 94.—Mouth-parts of *Pediculus vestimenti*, showing rostrum and extensile tube—greatly enlarged (after Schiodte).

THE CRAB LOUSE.

(*Phthirius inguinalis* Leach.)

If we may depend upon ancient writers, this species has long been a companion of man. According to Denny it is recorded by Herodotus, and according to Piaget was referred to in the writings of Aristotle. Some of the ancient accounts treat of it as occurring in the most prodigious numbers and causing most serious ailments to the infested parties. The disease produced gained the name of Phthiriasis, though doubtless this term has been applied also to the attacks of the other species of parasites infesting man.

Its attacks are said to be more severe than those of the other forms of lice, although it is quite probable that in the worst cases reported the different species have been present, since the conditions favoring the increase of one will also favor the others. The reports, especially of the earlier writers, have many of them doubtless been subject to great exaggeration, for while the normal rate of increase will account for the sudden appearance and rapid multiplication of the lice under certain conditions, it is not equal to the marvelous stories which are to be met with even in some works that lay claim to accuracy.

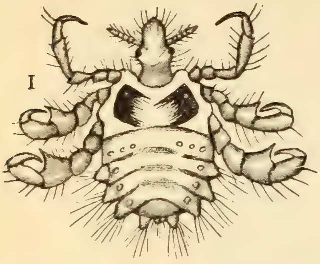

FIG. 95.—*Phthirius inguinalis*—enlarged (after Denny.)

The crab louse infests particularly the pubic regions, but occurs also among the stiff hairs under the arms, in the beard, and it is said also among the hairs of the eyebrows. It does not live in the fine hair of the head.

It is very distinct from the other species, the body being nearly as wide as long, while the strong legs spreading out laterally very greatly increase its apparent width and give it the form of a crab in miniature, thus winning for it the name of crab louse. It is of a whitish color, with a dusky patch on each shoulder, and with the legs slightly tinged with reddish, the claws having this color more pronounced. It is nearly one-tenth of an inch in length.

The remedies adopted for the head louse are applicable to this species, although it is said they are less effectual and must be persisted in more vigorously. Red precipitate is probably most frequently used.

THE HEAD LOUSE.

(*Pediculus capitis* DeGeer.)

This louse has been recognized under one name or another as far back as we have history. While very generally confused with the following species, it is probably the one most commonly known, though perhaps not the one which has caused the greatest amount of annoyance or that has occurred in the greatest numbers. The two species were not clearly defined till comparatively recent times.

Elaborate writings upon the louse were given by Swammerdam, Leeuwenhoek (1693), and descriptions of it by Redi, DeGeer, Linnæus, Geoffroy, Burmeister, Leach, and others, besides innumerable brief mentions and a goodly number of elaborate memoirs upon its embryology, etc. In later days, while a most annoying pest, it does not appear to have caused such serious results as the body louse or the crab louse.

It is confined to the fine hair of the head, rarely occurring on other parts of the body.

The eggs (nits) are white and glued to the hair at some distance from the head, and are most abundant, we have observed, back of the ears. When numerous they form quite conspicuous objects. The young, upon hatching from these, resemble the adults, except in size and in being less distinctly marked. The proportions of the body are also somewhat different, the abdomen being smaller than after it has become enlarged by a steady diet upon human blood. The full-grown lice are whitish, with faint, dark markings at the sides of the thorax and abdomen. The last segment of the abdomen in the female is bilobed.

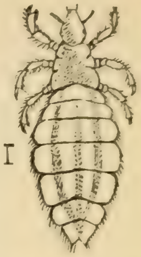

Fig. 96.—*Pediculus capitis* (after Packard).

Murray has shown that the different races of man harbor different varieties of this species of louse, the difference in the varieties being particularly in color and in the form of the claws. In color they differ from the nearly white infesting the Caucasians to the black infesting the African. The claws differ somewhat in proportions, and Murray thinks these differences constant, but they can at most be considered only as varietal differences.

Remedies are white precipitate, sulphur ointment, and especially cleanliness.

THE BODY LOUSE.

(*Pediculus vestimenti* Leach.)

As with the preceding species, the history of this parasite is lost in antiquity, and most of the early accounts failed to indicate any difference in the two forms. In the works of DeGeer, Leach, Denny, and others they are distinguished and well characterized.

This form is most common where opportunities for good sanitation are wanting, as in armies, prisons, and all places where attention to bodily cleanliness from choice or necessity is neglected.

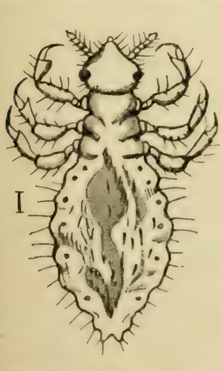

Fig. 97—*Pediculus vestimenti* (after Denny).

It is not known to infest animals, though we have seen specimens that were said to have been taken from cattle.

Until fully grown there is not much difference to be noted in the appearance of this and the preceding species, though the markings at the sides are less distinct. In the adult form, however, the dorsal surface is marked with dark transverse bands.

The insect secretes itself in the folds of the clothing, only penetrating the skin when in want of food. The long, slender sucking tube, by means of which it reaches the small blood vessels near the surface, is shown fully extended in figure 94.

The eggs are deposited in folds of the clothing, and, according to the estimates of Leeuwenhoek, a single adult female may have a progeny of 5,000 in eight weeks, and he adds that in the heat of summer this estimate might be very greatly exceeded. This will readily account for all the authentic reports of sudden and numerous appearances of this pest.

A ready means of combating this pest is to thoroughly bake the clothing infested with it, or, to be fully as effectual with less heat, this might be accompanied by fumigation with sulphur or tobacco smoke. A repetition of this process two or three times at intervals of a few days, along with strict personal cleanliness, should overcome the most serious attack.

Alt described, under the name of *Pediculus tabescentium*, the louse which he considered as the cause of phthiriasis, but later authorities consider this as simply the *vestimenti* present in aggravated numbers. Properly speaking, this affection should be termed pediculosis, and the term phthiriasis reserved for the attacks of *Phthirius inguinalis*.

LOUSE OF THE APE.

(*Pediculus consobrinus* Piaget.)

Closely related to the human lice is a species described by Piaget occurring upon the Ateles ape (*Ateles pentadactylus*). It resembles especially the *Pediculus capitis*, but presents some differences in form of head and structure of abdominal appendages which have led this author to establish the separate species. It appears to differ less, in general appearance, from typical *capitis* than the varieties of *capitis* occurring on different races differ among themselves.

Though there is considerable difference in the drawings, this is probably the same species that is figured by Murray (Economic Entomology, p. 389) under the name of *Pediculus quadrumanus* and said to be taken from the Ateles ape.

LICE INFESTING THE MONKEY.

(*Pedicinus* spp.)

Three species of lice are found upon monkeys, all being generically distinct from those infesting other animals. They form the genus *Pedicinus*, the most essential character of which is the presence of but three joints in the antennæ.

The species are the *Pedicinus eurygaster* Gervais, which occurs upon the macaques, *Macacus nemestrinus*, *cynomolgus*, and *radiatus*, according to Piaget, and *Macacus sinicus*, according to Giebel; the *Pedicinus longiceps* Piaget occurring, according to its author, upon the *Macacus cynomolgus* and the *Semnopithecus pruinosus;* and the *Pedicinus breviceps* Piaget infesting the *Cercopithecus monas*.

Aside from these species of Pedicinus, Gervais describes a species of Hæmatopinus, *H. obtusus*, from the *Semnopithecus maurus*.

The abundance of these vermin upon monkeys can be attested by all visitors of zoological gardens or menageries, and the ready means adopted by the hosts for their subjugation are equally familiar—a method of destruction which, by the way, is said to be adopted by many tribes of inferior races belonging to the human species.

The Sucking Dog Louse.

(*Hæmatopinus piliferus* Burm.)

Although the dog has been the closest companion of man among the domestic animals from very early times, and consequently this parasite, in all probability, was well known to keepers of dogs, it was not technically described until about the year 1838.

It does not appear to have been a very numerous or injurious parasite, apparently much less so than the *Trichodectes latus* infesting the same animal, and less annoying than either ticks or fleas. Denny says (Monog. Anop. Brit., p. 29): "I have found it upon dogs two or three times, but it is by no means of common occurrence." We have examined many dogs in quest of it, but only a single specimen so far has been our reward. Denny says (loc. cit.): "I also received specimens from the ferret." It can hardly be inferred, however, that this animal is consequently a normal host for the species, as such an instance might occur entirely from accident, the louse having been transferred from some dog to a ferret associated with it.

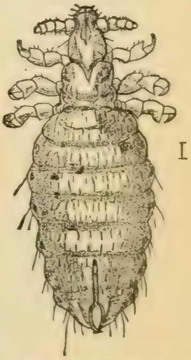

Fig. 98.—*Hæmatopinus piliferus* (author's illustration).

This species is somewhat smaller than the lice infesting most of the larger mammals, the full-grown individuals being nearly one-tenth of an inch long. It is described generally as of a light-red or ashy flesh color, but evidently varies as the other species, according to the condition of the body as well as the age of specimens. In preserved specimens these colors become lighter, assuming a yellowish hue, the abdomen, except where darkened by the intestine and its contents, appearing a shade lighter than the front part of the body. The abdomen is thickly covered with fine hairs and minute warty eminences, these latter when magnified about 300 diameters appearing like the scales of a lizard or fish.

Specimens from different breeds of dogs do not appear to have been noticed as different, although a form described as *H. bicolor* by Lucas may perhaps be found to present race characteristics.

THE LOUSE OF THE CAMEL.

(*Hæmatopinus cameli* Redi.)

We follow Giebel and Piaget in admitting this species, although it does not appear to have been observed by any modern naturalist.

Piaget says (Les Pédic., p. 644): "La figure que donne Redi, le seul qui ait observé cette espèce, se rapproche beaucoup de celle de l'*urius*."

LICE INFESTING THE GIRAFFE, DEER, AND ANTELOPE.

(*Hæmatopinus* spp.)

Closely related to the lice infesting the other hoofed quadrupeds are those infesting respectively the giraffe, deer, and antelope. The species infesting the giraffe (*Camelopardalis giraffa*) was described by Giebel under the name *Hæmatopinus brevicornis;* that infesting the deer was first mentioned by Redi and described and named by Nitzsch as *Hæmatopinus crassicornis;* it is recorded from the red deer (*Cervus elaphus*). The *Hæmatopinus tibialis* Piaget, from *Antilopa maori*, is, according to its author, represented by varieties on the *Antilopa* sp. and the *Antilopa subcutturosa*, and he considers it possible that the *H. cervicapræ* Lucas, from *Antilopa cervicapra*, is also a variety of this same species.

THE SUCKING LOUSE OF THE GOAT.

(*Hæmatopinus stenopsis* Burm.)

We have no record of this species having been observed in this country, and judging by the references to it in standard works it must be of rather rare occurrence in countries where these animals are kept in greater abundance than here.

The species is not, so far as at present known, transmissible to any other domestic animal, and if ever becoming abundant, will doubtless yield to the treatment used for the other species, though the long hair would make some of them more difficult of application. On this account pyrethrum would seem to be most practicable.

THE SHEEP FOOT LOUSE.

(*Hæmatopinus pedalis* n. sp.)

We would hardly expect to find an entirely new form of louse on so common a domestic animal as the sheep at this late period of investigation of animal parasites. I am able to announce, however, a species which seems to have entirely escaped observation heretofore, and, moreover, to describe a habit of distribution of the parasite on its host which has, so far as I know, no parallel among the related species. This suctorial louse of the sheep occurs only, as all examinations so far indicate, upon the legs and feet below where the long wool is found. It is especially common to the region of the "dew claws," where the eggs appear to be most commonly deposited.

It is of about the same general shape as the short-nosed ox louse, though scarcely so broad and rather smaller. The dark, chitinous portions of the body are much restricted, so that it has a more immature look than the *eurysternus.* Its maturity, however, is fully shown by the development of the genital organs.

It no doubt passes through its various stages of development just as the related species, and so far nothing can be said as to the exact time required in reaching maturity. Eggs and adults were collected in January, but eggs carried in a vest pocket in a small vial so as to be kept warm did not hatch. The figure will show the characteristic form and structure.

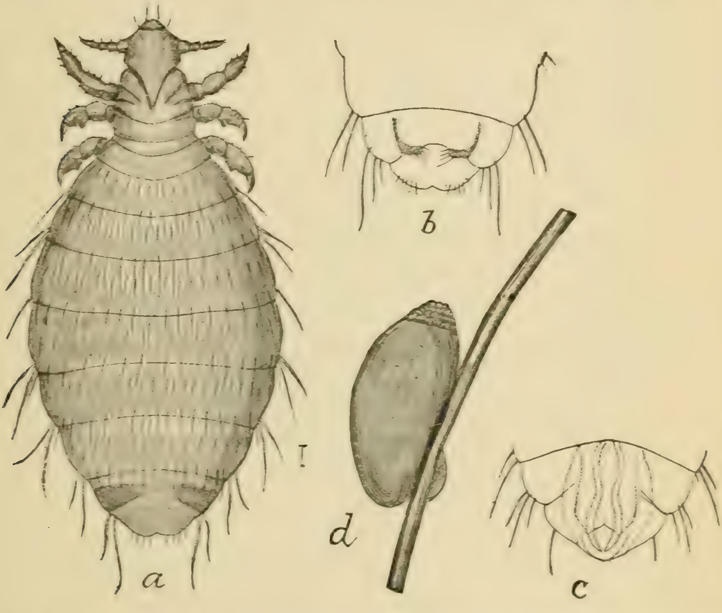

FIG. 99.—*Hæmatopinus pedalis:* *a*, adult female; *b*, ventral view of terminal segments of same, showing brushes; *c*, terminal segments of male; *d*, egg.—all enlarged (original).

The fact that this species is confined to the lower part of the legs and does not occur on the parts of the body covered by long wool is a very important one, and one which makes it an easy matter to treat the pest at any season of the year. The feet and legs can be washed with any of the effective dipping solutions, or the sheep may be driven into a shallow vat of the solution with enough of the solution to reach up to the body without wetting the wool. Dipping at shearing time for ticks and biting lice will destroy these also, so that if the practice of an annual dip is followed there should be no trouble from this new pest.

Hæmatopinus pedalis n. sp. Female: Head and thorax comparatively small; abdomen fusiform, tapering. Length, 2.20 mm.; width of abdomen, 1 mm.

Head short, as wide as long, bluntly contracted in front of the antennæ, with few hairs. Antennæ large, annulate with reddish-brown, terminal joint with three or four bristles. Occiput merging into thorax, with prominent reddish oblique bands either side, becoming approximate on the thorax. Thorax wider than long, with anterior faint and posterior distinct band not meeting on median line of dorsum. Legs not differing markedly in size, but anterior smallest and posterior largest; middle and posterior tibiæ with very prominent, spoon-shaped process opposed to tarsal claw, marked with red-brown bands.

Abdomen oval, fusiform, thick, rising high above the thorax, sparsely set at base with irregularly scattered small hairs, those at margin a little longer and more regularly placed; spiracles inconspicuous, pleural, not marked by chitinous tubercles; brush organs on seventh segment rather small, ∟-shaped, the bristles on the end very small; terminal segment set with a cluster of small spines either side, ventrally.

Male: Broader and flatter than the female. Two brownish lines on posterior ventral segments, converging to tip of abdomen; forked genitalia, showing through the transparent body wall.

Eggs attached on hair of lower leg and foot a short distance from the skin, of about the usual form, rather long, surface shining, minutely punctured.

Collected at Ames, Iowa, from domestic sheep (*Ovis aries*). These sheep had been recently imported from Canada. The lice did not occur on more than a few animals.

THE SHORT-NOSED OX LOUSE.

(*Hæmatopinus eurysternus* Nitzsch.)

This is probably the species that has been familiar from early time as the louse infesting cattle, though since this species and the following one have been generally confused, it is impossible to say which has been most common. It was first accurately described by Nitzsch under the name of *Pediculus eurysternus* in 1818 (Germar's Mag., Vol. III, p. 305), and has received mention in every important treatise on parasites since that date, as well as innumerable notices under the head of animal parasites, cattle lice, etc. As with other species, the disease produced has been termed phthiriasis, and as treated by Kollar and other writers, it has been recognized as a most serious pest and numerous remedies tried for its suppression.

Since it has been very generally confused with the following species, we shall give more particular description and show as clearly as possible how to distinguish them. The following quotation from Mr. C. W. Tenney (in Iowa Homestead for August 18, 1882) will show that this difference is not without interest or value as viewed by a practical breeder: "Then there is a blue slate-colored louse and a larger one of the same color that vary somewhat in their habits, and the last mentioned is the hardest to dislodge." Evidently it is the species under discussion to which Mr. Tenney refers as the "larger one." It infests particularly the neck and shoulders, and these parts are frequently worn bare by the efforts of the animal to rid itself of the irritation produced by these unwelcome visitors. Still, some cattlemen say that these parasites are of no consequence, and that they never pay any attention to them.

The full-grown females are about one-eighth to one-fifth of an inch long, and fully half that in width, while the males are a little smaller and proportionately a little narrower. Aside from the difference in size the sexes differ very decidedly in the markings and structural features upon the under side of the body. The males have a broad black stripe running forward from the end of the body to near the middle of the abdomen, as shown in figure 100, *c*.

The females have no indications of this stripe, but the black, broken band of the upper side of the terminal segment extends slightly around on the under side. The most important character, however, is the presence of two little brush-like organs on the next to the last segment, as shown in figure 100, *d*.

The head is bluntly rounded in front, nearly as broad as long, and with the antennæ situated at the sides midway from the posterior to the anterior borders; behind these are located slight eminences upon which may be found the small eyes, which are seen with considerable difficulty. At the front of the head may be seen the small rostrum or beak, the end of which is usually at or near the surface, but which is capable of extension and retraction. The end of this beak is armed with a double row of recurved hooks (see fig. 100, *b*). The function of these hooks is doubtless to fasten the beak firmly into the skin of the host, while the true pumping organ must consist, as in the Pediculi, of a slender piercing tube, though we can see only slight indications of this tube within the head, and we have not seen it nor do we find any record of its having been seen fully extended in this species. Professor Harker says the rostrum can be pushed out, but his figure shows only the basal portion with the crown of hooks and nothing of the tubular parts inclosed within.

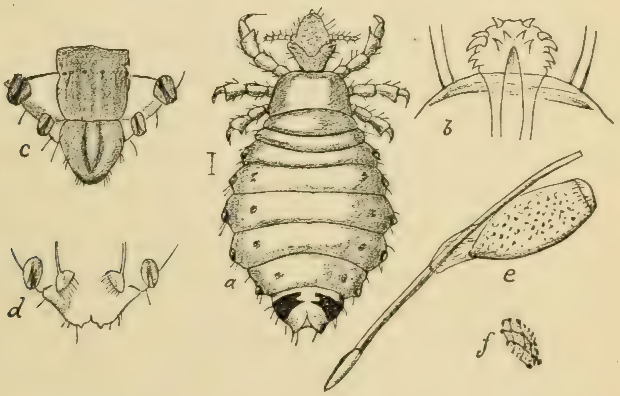

FIG. 100.—*Hæmatopinus eurysternus: a*, female; *b*, rostrum; *c*, ventral surface of the last segments of male; *d*, same of female; *e*, egg; *f*, surface of same greatly enlarged (author's illustration).

The thorax is wider than long and widest at the posterior margin where it joins the abdomen. The legs project from the side, are long and stout, and especially adapted to clasping and clinging to the hair.

An extra provision for this purpose consists of a double plate having fine transverse ridges in the basal joint of the tarsus. This structure appears to have been first described by Professor Harker (Agricultural Students' Gazette, Vol. I, p. 162). The abdomen differs greatly in form and size, according to the degree of distention, which accounts for the discrepancies in the different figures of this species. It may be called flask-shaped and more or less flattened according to the amount of matter contained in it. There is a row of horny tubercles along each side and a row of chitinous plates along each side of the upper surface of the abdomen. The spiracles are located in the tubercles at the sides, and there is one to each of the last six segments, omitting the terminal one. In color there is some variation, as would be surmised from a comparison of descriptions by different authors. The general color of the head and thorax is a light brown approaching to yellowish, with touches of bright chestnut on the head and legs and margins of the thorax, also touches of dark brown on these parts, more particularly on the dorsal portion of the thorax. The abdomen in fresh specimens has a general bluish aspect, not so noticeable in preserved specimens, besides its color depends evidently in large degree upon its contents. Denny says "grayish-white or ochraceous gray," which would apply well to preserved specimens, but his plate shows it a blue-gray. Harker says brownish gray. It appears to us that the term used by Mr. Tenney, blue slate-colored, comes quite as near describing the average appearance as any that we have seen. The tubercles at the side of the abdomen and the chitinous plates are chestnut-colored, while the most of the upper surface of the terminal segment in the female and the ventral stripe in the male are black.

The females deposit their eggs on the hair, attaching them very near the skin. Figure 100, *e* represents one of the eggs, showing its attachment to the hair and the distance from the root of the hair in the specimen drawn. The adhesive substance evidently invests the egg during oviposition and is touched to the hair, the egg then slightly drawn along so as to leave the glue-like mass to form a firm union around the hair and to the egg. The egg is elongate-oval, tapering at the lower end, and having a cap-like covering at the upper end. The surface is set with very minute points just visible under an inch objective, but showing clearly with a power of 300 diameters. At the surface no connection is to be seen between different points, but focusing a little below the surface brings into view what appear to be minute threads or channels running from point to point and giving a reticulate appearance to the eggshell. The points can not correspond to the circular bodies represented in Denny's figure (E, Pl. XXV, Monog. Anop. Brit.), which have much more the appearance of protoplasmic granules of the egg contents. The shape of the egg in his figure is also entirely different from that of the specimen from which our figure is drawn.

The young louse escapes from the outer or unattached end, whether by pushing off the cap-like portion or by simply pushing through this portion, which appears to be thinner than the rest and may be simply membranous, is not, so far as we know, determined. No marked changes, except in size and the development of the chitinous patches, occur from hatching to maturity.

This is one of the most difficult parasites to destroy, and once settled upon an animal should receive prompt and thorough treatment. The main reliance of veterinarians seems to be stavesacre, and this can doubtless be depended upon to accomplish the desired end. Mr. Tenney recommends the seed of common larkspur steeped, and the animal thoroughly washed with the liquid. He says: "I have known one application to destroy every insect and egg; two will suffice if done thoroughly." Of course this and the stavesacre are nearly identical, both plants belonging to the genus Delphinium. Washes of carbolic-acid soap or of tobacco infusion are also effectual, but washes of any kind are of course illy adapted to use in midwinter, the time when there is frequently most necessity for treatment. Mercurial ointment, sulphur, or tobacco smoke, kerosene and lard, or kerosene emulsion, road dust, ashes, etc., may be resorted to, according to the circumstances. Infested animals should, if possible, be placed apart from the others, and much trouble may be saved by this precaution.

Experiments with fumigation have shown this to be a method available when other plans are undesirable, though from the equipment necessary, and the fact that it requires some time in application, it may not prove of as general service as the washes.

The method may be said in brief to consist of a tight box stall just large enough to admit the largest animals to be treated, one end having a close-fitting door to admit the animal, the opposite end a stanchion in which the animal is fastened, and covering the open part of this end, and made to fit tightly around the head just in front of the horns, is a canvas sack open at both ends, the inner one nailed to the stall and the outer with a running cord to draw it down to the animal's head, thus leaving the eyes and nose in open air. An opening at the bottom of one side admits the fumigating substance, sulphur or tobacco, the latter apparently the most effective. In burning this we used a wire screen to spread the tobacco, placing this over a tin trough containing a small quantity of alcohol. It should be burned, however, with coals or by using a small quantity of kerosene. The time of exposure necessary will vary some with the strength of fumes, but 1 to 2 ounces of tobacco and exposure of twenty to thirty minutes was found effective. Pyrethrum might be better even than tobacco.

This species has been said to occur also on horses; but if this is the case it must be in rare instances, and there need be little apprehension of horses becoming infested with it by transmission from cattle with which they may be associated.

THE LONG-NOSED OX LOUSE.

(*Hæmatopinus vituli* Linn.)

In connection with the preceding species this louse, as already stated, has long been familiar to cattlemen; it has also been known to entomologists for a considerable time, but its history from the entomological side is not entirely clear. It seems to have been first technically described by Linnæus under the name of *Pediculus vituli*, which name has been followed by Fabricius, Berkenhout, Stuart, and Turton, and, with the exception of the change in the generic name, by Stephens, Denny, and English and American authors generally. Nitzsch described it under the name of *Pediculus oxyrhynchus*, which name was Latinized by Burmeister to *tenuirostris*. This designation has been followed by Giebel and Piaget, but why the earlier name of Linnæus was dropped we fail to discover. It seems more proper to retain the name given by Linnæus.

Denny describes and figures the species and says that it has been found only on the calf. Giebel also figures and describes it, giving a very characteristic figure, though deficient in some details. Piaget admits the species provisionally, but questions it being separable from *eurysternus* from the fact that descriptions have been based only on female specimens or on those in which the sex was not distinguished, and he seems to think it probable that immature specimens of *eurysternus* may have furnished the basis for this form.[1]

From material in hand there can be no question whatever as to there being a distinct form corresponding with the descriptions above cited, and, while there are some details still to be cleared up, we propose to show as fully as possible the differences. While our material[2] does not include any specimen that can be recognized as a male, it does include enough specimens of the early stages and females of both this species and the *eurysternus* to entirely set at rest any question as to immature forms of *eurysternus* having been described as *vituli* or *tenuirostris*.

In this species the body is about one-eighth of an inch long and not more than one-third of that in width (see fig. 101). The head is long and slender, the antennæ set near the middle each side; there is but a very slight protuberance behind the antennæ and no eyes visible. The head sets well back into the thorax, forming an acute angle behind; the thorax is longer than wide, and has a distinctly visible spiracle above the second pair of legs; the abdomen is elongate, without chiti-

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[1] Since the preparation of this section and the figures illustrating the species I have seen the supplement to Piaget's Les Pédiculines and find that he now admits this as a good species and gives a figure of the female, without, however, any special details of structure.

[2] A series of parasites kindly loaned to me by Dr. A. W. Bitting, of Purdue University, Indiana, contains a set of *vituli* among which I find a male. It agrees with females in general shape and external characters, except brushes, but is considerably smaller. Length, 1.75 mm.; width, 0.50 mm.

nous plates and devoid of any tubercles along the sides; the terminal segment is also devoid of a black horny band; the brush-like organ on the under side of the abdomen (see fig. 101) is slender, while the terminal segment is set with numerous rather long hairs.

In all of these points it will be observed there is a distinct difference from *eurysternus*. The brush-like organ on under surface of the abdomen, common to the adult females of related species and which is wanting in young specimens of all species, must be taken as distinct evidence of the maturity of the specimens. If, however, there were any doubt on this point a study of the young of *eurysternus* gives equally conclusive testimony. In the very youngest *eurysternus*, the chitinous tubercles along the sides of the abdomen inclosing the spiracles are distinctly to be seen, while the head, though longer proportionately than in adults, is by no means equal in length to that of adult *vituli*. A young *vituli*, found, it is true, associated with *eurysternus*, shows this elongation of the head still more markedly. In color there is little difference in the two forms, this species having rather duller colors upon the head and thorax. The abdomen of young specimens, when full of blood, appears dark red, but the bluish-gray hue is more prominent in adults. The eggs of this species have not been described, and we have not had the good fortune to discover them. The young are even more slender than the adults.

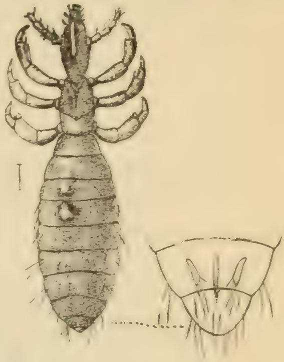

FIG. 101.—*Hæmatopinus vituli:* female, under surface of last segments of abdomen of same, showing brush-like organs—enlarged (author's illustration).

The remedies that are available for the preceding species will prove effectual for this, and it is evidently less difficult to subjugate than that form.

THE BUFFALO LOUSE.

(*Hæmatopinus tuberculatus* Burm.)

This species was described by Burmeister (Gen. Ins.) under the name of *Pediculus tuberculatus*.

It is described in Giebel's Epizoa, page 46, and described and figured by Piaget (Les Pédic., p. 650, pl. 53, fig. 2). It is compared by Giebel with the hog louse and by Piaget with the *H. eurysternus*, which from his figure it seems most nearly to resemble. According to Piaget, this species is probably identical with the *Pediculus* (*H.*) *phthiriopsis* of Gervais (Aptères, III, 306) from the *Bos cafer* and with the *Pediculus* (*H.*) *buffali* of DeGeer (Mem., VII, 68), in which case the name given by DeGeer should be adopted for the species. Rudow (Zeits. f. d. ges. Naturw., XXXIV, 167) describes a species under the name of *Hæmatopinus punctatus*, from the *Bos grunniens*, which possibly will be found referable to this same species.

Whether the same species occurs on our American bison is not known, but the unfortunate extermination of this animal renders the question, from a practical standpoint, of little importance. Lucas describes and figures the species in the Annales de la Société Entom. de France (1852, ser. 2, tom. X, p. 531, pl. 11, No. II), referring it to the species described by Burmeister in 1838 in the "Genera Insectorum." Specimens, he says, occurred in immense numbers on a *Bos bubalus* in the Museum of Natural History.

THE HOG LOUSE.

(*Hæmatopinus urius* Nitzsch.)

Occasionally this species appears in formidable numbers, since we often hear of swine badly affected with lice, and no other species is known to attack this animal.

Giebel credits this species to Moufet, citing the Theatrum Insector (1634, 266), while Piaget states that it is cited by Moufet on the authority of Albertus (IV, C. 205), which would carry its recognition back to the thirteenth century. Linnæus described it under the name of *Pediculus suis*, which name has been most commonly followed, but Nitzsch revived the name of *urius* and this name has been followed by Giebel and Piaget. Along with other parasites it received frequent mention by both early and modern writers. Denny speaks of it as rare in England, but common in Ireland. He says (Monog. Anop. Brit., p. 35):

> This species is found in great numbers on swine, but it does not appear so generally spread as might be expected from the dirty habits of the animals. It most frequently occurs on those fresh imported from the sister isle. It was many months before I could obtain a single example. I had applied to both farmers and pig butchers, neither of whom seemed to approve of the idea which I had conceived, that of their pigs being lousy, but referred me to those of the Emerald Isle as being sure to gratify my wishes (forgetting, I suspect, that the Irish pigs come to this market to meet English buyers). I accordingly visited a colony just arrived, where I most certainly met with a ready supply; but here they were confined almost entirely to lean animals, and wherever I found a pig fat or healthy no game were to be seen.

Most stock breeders have probably seen instances of its abundance, and from the frequent mention of it in the agricultural papers it would seem to be quite common throughout the country, and while, perhaps, less generally distributed than the ox louse, to multiply sometimes so as to cause much more apparent damage to its host. The fact that they are more commonly found on poor or runty animals should not be taken as evidence that they have a preference for such animals, but rather that the animals upon which they have multiplied rapidly have, in consequence, become emaciated and unhealthy. That they do not increase more rapidly and become a much greater nuisance may be in part because the majority of hogs are sold and slaughtered at a comparatively early age, and with each one slaughtered must perish the parasites which have been supported by it, unless, perchance, an occasional one escape the scalding trough and succeed in finding another host. Of the vast number of hogs shipped to market and slaughtered at the great packing houses, none can bequeath the insects they have nurtured to their followers. The amount of injury and the consequent need of precautionary measures are therefore much less for this species than for many others.

This is one of the largest species of the family, full grown individuals measuring a fourth of an inch or more in length. It is of a gray color, with the margins of the head and thorax and most of the abdomen dark. The head is quite long, the sides nearly parallel, with strong eminences just back of the antennæ, which are set on the sides of the head, midway from rostrum to occiput; the legs are lighter, with dark bands at the joints; the spiracles are inclosed by a black chitinous eminence, and there is a broad black band on the last segment, broken near the middle. (See fig. 102.)

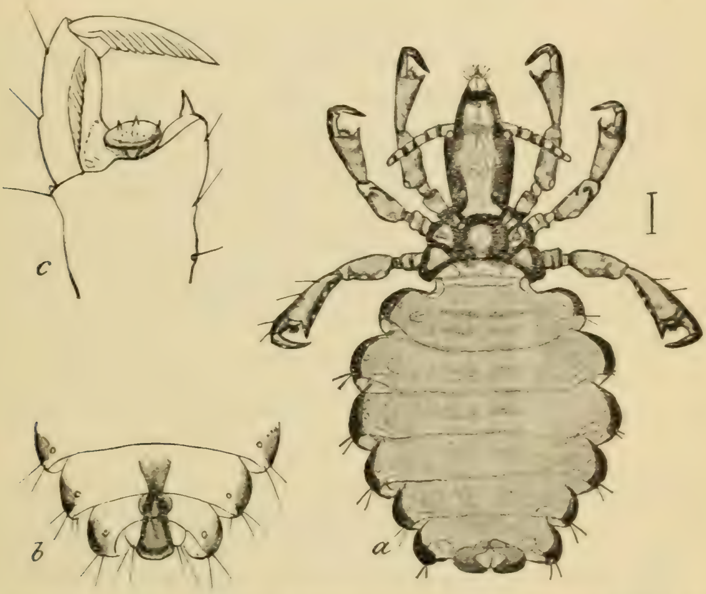

FIG. 102.—*Hæmatopinus urius:* *a*, female; *b*, ventral view of posterior segments of male; *c*, leg, showing protractile disk of tibia—enlarged (author's illustration).

The male has the abdomen marked beneath with a large black area extending forward from the end of the terminal segment, so as to occupy the central portion of the last three segments.

There is a curious provision in the feet for strengthening the hold upon the hair, which does not seem to have been hitherto described. It consists of a circular pad-like organ or disk in the outer portion of the tibia, which is received in a conical cavity in the end of the tibia, and which can be forced out so as to press upon the hair held between the claw of the tarsus and the end of the tibia. Ordinarily, and always in the dead specimens, this is withdrawn so as to appear simply as a part of the end of the tibia, and the spines located on its margin appear to belong to the tibial rim, but if examined with sufficient magnification when the louse is alive it is easy to observe the extrusion of the organ.

Whether similar organs exist in related species is yet undetermined, but it seems quite probable that they should, since in the specimens examined microscopically we have usually to deal with dead and preserved individuals in which this structure would almost certainly escape notice.

The eggs are one millimeter and a half in length (0.06 inch) by three-fourths of a millimeter in width (0.03 inch). They are light yellow or dusky whitish in color, and taper slightly to the point of attachment. The circular lid-like portion is large, occupying nearly all the surface of the free end of the egg. They are attached usually near the base of the hairs.

On account of the thinness of the hair the application of remedies, where necessary, is quite easy. Washes of tobacco water or dilute carbolic acid, and the application of kerosene in lard, or kerosene emulsion by means of a force pump, sulphur, ointment, etc., are recommended. The application of fine dust may be provided for naturally by allowing the hogs a chance to roll in a roadway or any place well supplied with fine dust. Where this is impracticable the dust, ashes, or powdered charcoal may be applied directly to the neck and back of the infested animal. The species is not known to attack any other of the domestic animals, and hence no precautionary measures in this direction are necessary.

The Sucking Horse Louse.

(*Hæmatopinus asini* Linn.=*macrocephalus* Burm.)

Notwithstanding the probable frequent occurrence of this species, we have as yet failed to meet with it in any abundance. The biting lice from horses have been secured in great numbers, but we have searched in vain for this one, and but few have come to hand.

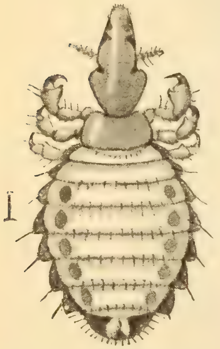

Fig. 103. — *Hæmatopinus asini* (from Comstock).

It is figured by Redi (Exp., Pl. XXII, fig. 1), and was described by Linnæus under the name of *Pediculus asini;* presumably his specimens were taken from the ass. Later Burmeister described specimens from the horse under the name of *Pediculus macrocephalus.* Denny retains the name given by Linnæus and states that it is common upon the ass, and that he also had specimens from the horse, from which circumstance he suspected Burmeister's *macrocephalus* to be the same Giebel and Piaget both follow the name of Burmeister, and Piaget separates as a variety the form occurring on the ass, and gives it the name of *colorata.*

It seems hardly probable that it occurs in this country in sufficient numbers to cause much trouble on horses. Possibly examination of mules, asses, or donkeys would show greater abundance from the fact that horses in general are more carefully groomed than their somewhat despised relatives. The size is about the same as that of the ox louse, but it differs very decidedly in the form of the head, which is long, slender, and the sides of the head nearly parallel, as shown in the figure (fig. 103), taken from Comstock's Introduction to Entomology.

Careful grooming may be looked upon as at least favorable to the reduction of numbers in this species. In case they become too numerous, the application of a little kerosene to the card or currycomb used in grooming the animals will be found of value. Where more vigorous treatment is necessary, the measures recommended for the ox louse may be adopted.

SUCKING LICE OF RODENTS.

(*Hæmatopinus* spp).

Belonging to the same genus of suctorial lice as those previously mentioned, we have a number of species common to the smaller mammals, particularly those of the group of gnawing mammals, the Rodentia.

These smaller mammals, though perhaps never strictly domesticated, save the rabbit, are very often kept in a semidomesticated state, either as pets in zoological gardens, or, in case of rats and mice, quite involuntarily because of our inability to entirely rid ourselves of them. A few notes on the lice infesting them will therefore be of interest here. It is desirable to be able to identify them in case of their accidental occurrence on other mammals, and thus be able to determine whether, in such cases, we have to deal with a species likely to prove troublesome.

LOUSE OF THE RAT.

The common rat (*Mus decumanus*) supports a species, *Hæmatopinus spinulosus*, which, with its host, must be distributed over most of the world. It has been taken at Ames, Iowa, though in small numbers, and it seems to be rather scarce.

It is a small species of a light-yellow color, the head projecting very little in front of the antennæ and the thorax very short. The mice are said to harbor a distinct species, but there seems to be some doubt as to its being a genuine species.

LOUSE OF THE FIELD MOUSE.

(*Hæmatopinus acanthopus* Burm.)

Apparently common on our species of Arvicola, and does not appear to vary in any important particular from the descriptions of European specimens.

It has been taken at Ames from a species of Arvicola. It resembles the preceding in color and form, but is somewhat larger. The sternal plate is kite-shaped, the anterior and posterior angles acute, the lateral angles rounded. The body is quite elongate, the posterior legs much larger than the anterior or middle ones. (Fig. 104.)

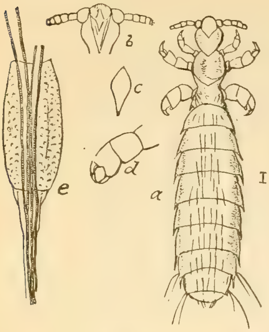

FIG. 104.—*Hæmatopinus acanthopus: a*, dorsal view; *b*, head; *c*, sternal plate; *d*, posterior leg; *e*, egg—all enlarged (author's illustration).

The egg in this species, unlike those of other forms we have met, is attached to a bundle of hairs instead of to one, our specimen thus having attachment to four hairs, as shown in fig. 104. This would seem to be an excellent provision where the hair is so fine as in these animals.

The egg is elongate oval, broad, and somewhat truncate at the attached end; the surface is roughened, rugulose, or foveolate, appearing squamous in places, and in section showing rounded pits on the surface; the investing substance at base is slightly corrugated. (See fig. 104, *e*.)

The larva is much shorter and thicker in proportion than the adult, the spiny hairs of the abdomen wanting, but with one or two long, slender hairs extending back from the terminal portion.

LOUSE OF THE RABBIT AND HARE.

(*Hæmatopinus ventricosus* Denny.)

In this chapter, first published in Bulletin 7, it was stated that the rabbit louse had not been observed in this country; but shortly after specimens were received from Mr. A. Hassall, of Baltimore, and I have since taken the species on the prairie hare (*Lepus campestris*), and it most likely occurs on the various species of rabbits native to America.

It is a thick-bodied species, the abdomen almost globular, the legs quite short. It is not known from any other animals.

LOUSE OF THE FLYING SQUIRREL.

(*Hæmatopinus sciuropteri* Osb.)

Body slender, light yellow, head as broad as long, expanding laterally at the posterior border above and with an acute angle behind; beneath triangular and running back to a sharp angle between the anterior legs, the front projecting very slightly beyond the antennæ, very slightly convex, the rostrum located back of the anterior border; the trophi plainly visible, passing back into the prothorax; the antennæ very large and strong, first joint much the largest, occupying in its attachment half the lateral margin of the head; second joint ordinary, third joint very short, but the anterior portion extending to more than usual length and appearing like a process and bearing a stiff hair and two or three tooth-like spines; the fourth joint attached apparently very near the base of the third on posterior side and of usual length; the fifth joint short, the terminal pit with two or three short hairs; the postero-lateral angles of the head armed with a long, stiff hair.

Thorax widening from before backward, longer than its greatest width, lateral borders irregular, the posterior border concave; the sternal plate is very large, emarginate in front and a large emargination corresponding to each leg, deeply bilobed posteriorly; anterior legs not half the size of the others, claws weak; posterior legs largest. These and second ones provided with strong clasping claws, or terminal joint of tarsus, opposing basal joint of tarsus, which is provided with corrugated plate; tibia at apex internally provided with a short toothed spine.

Abdomen of eight segments, elongate, each segment sparsely set with short, very stiff hairs, those at lateral angles spine-like; penis distinct, of ordinary form. (See fig. 105.)

Egg elongate ovate, attenuated toward the attachment, the surface with faint reticulations having form of scales; the basal half of the egg has the walls beautifully corrugated. (See fig. 105, *f.*)

Length, 1.20; head, 0.27; thorax, 0.27; abdomen, 0.73; antennæ, 0.16 mm. Width, 0.33; head, 0.26; thorax, 0.30; abdomen, 0.33 mm.

Posterior femur, length, 0.10. Posterior tibia, length, 0.10. Egg: Length, 0.80; width, 0.18 mm.

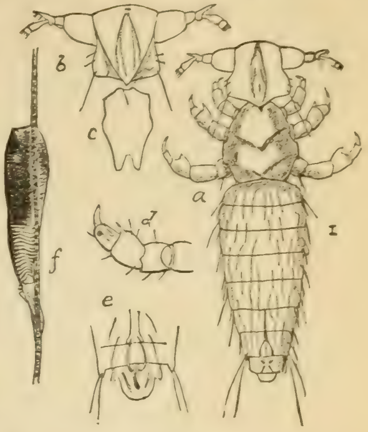

FIG. 105.—*Hæmatopinus sciuropteri: a*, male, dorsal view; *b*, head, ventral view; *c*, sternal plate; *d*, leg; *e*, terminal segments; *f*, egg—all enlarged (author's illustration).

This species, in the form of the head and the character of the antennæ, differs very decidedly from most of the other members of the genus and is readily distinguished by these characters, as also by the form of the sternal plate.

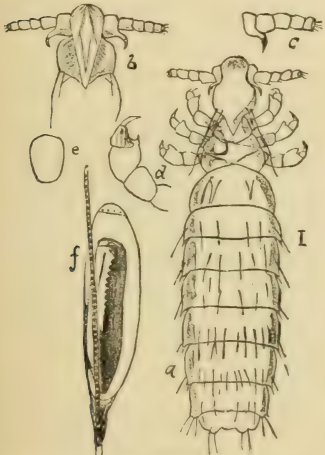

FIG. 106.—*Hæmatopinus antennatus: a*, dorsal view; *b*, head, ventral view; *c*, antenna; *d*, leg; *e*, sternal plate; *f*, egg—all enlarged (author's illustration).

One specimen male and one egg taken from different specimens of the flying squirrel, *Sciuropterus volucella*, but undoubtedly belonging to the same species.

Collected at Ames, Iowa; also represented in the Burnett collection of the Boston Society of Natural History from the same host.

LOUSE OF THE FOX SQUIRREL.

(*Hæmatopinus antennatus* Osb.)

Body long and slender, the abdomen proportionately large.

Female.—Head narrow and rounded in front, widening decidedly behind the antennæ, deeply hollowed beneath the lateral margin, the postero-lateral margin subacute, bearing a short spine-like hair and a long stiff hair, the posterior border with an acute angle behind; beneath broadly keeled, keel behind narrow, expanding in front to width of head between the antennæ. Antennæ very different from other members of the genus; the first joint large with a short process on the posterior border bearing a sharp inwardly curved tooth; other joints ordinary, second joint longest. Thorax short, widest behind, sternal plate ovate, broadest in front, legs as with allied forms, the posterior pair strongest. Abdomen long, lateral angles produced, bearing a short spine or tooth, a short stiff hair and a long hair; a tuft of hairs on lateral angles of the eighth segment. Egg elongate ovate, surface smooth throughout except at the cap, which is strongly convex and has a row of perforations near the attachment to the body of the shell.

Length, 1.55 and 1.65; head, 0.35; thorax, 0.13; abdomen, 1.20; antennæ, 0.20 mm. Width, 0.50; head, 0.20; thorax, 0.22; abdomen, 0.50 mm.

Egg: Length, 0.73; width, 0.28 mm.

This species is at once distinguished from all others known by the peculiar structure of the antennæ, no other species described possessing the process and curved tooth of the basal joint. In form of head it approaches *acanthopus*, but is larger than that species and has the sternal plate of different form. The egg is longer, more attenuated at the base, and devoid of the surface markings characteristic of that species. Collected from a fox squirrel, *Sciurus cinereus* var. *ludovicianus*, at Ames, Iowa.

LOUSE OF THE GRAY SQUIRREL.

(*Hæmatopinus montanus* n. sp.)

Head rounded in front, projecting well in front of antennæ; antennæ strong, basal joint without hooked tooth, a bristle at each side behind. Sternal plate very broad in front, contracted behind for half its length, almost fungiform. Abdomen broad; hairs long, those on dorsum slightly irregular, mostly longer than length of segment, those at lateral angles longer. Length, 1.40 to 1.50 mm.

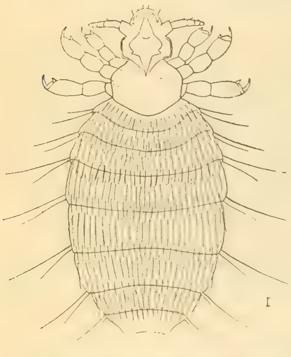

FIG. 107.—*Hæmatopinus montanus*—enlarged (original).

On Western Gray Squirrel, Fort Collins, Colo. (Baker).

I have still another form sent me by Dr. A. Hassall, of Baltimore, which seems to differ from both this and the *antennatus* and to approach the *lyriocephalus* of Europe, but I have not been able to satisfy myself with regard to its relationship.

LOUSE OF THE WHITE-FOOTED MOUSE.

(*Hæmatopinus hesperomydis* Osborn.)

Body elongate, general color golden yellow.

Female.—Head subquadrate, rounded in front, a concavity for the rostrum, obtusely angulated on the posterior border; antennæ set near the front; first joint large, short; second longest, the rest nearly equal; fourth with a small tooth on the posterior border, terminal pit with several short hairs. Thorax shorter than the head, small, sternal plate cuneiform, obtusely angular, irregularly or obliquely truncate in front and sharply pointed behind; anterior legs small and weak, the middle ones somewhat larger, the posterior pair much the largest, flattened; terminal joint of tarsus very broad and curved, opposing basal joint of tarsus and meeting tibial spur in such manner that the three form almost a complete cylinder; abdomen oval elongate, sparsely set with short spiny hairs, one or two long hairs at lateral angles of sixth and seventh segments.

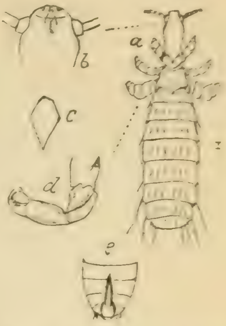

FIG. 108.—*Hæmatopinus hesperomydis*: *a*, dorsal view; *b*, head; *c*, sternal plate; *d*, posterior leg; *e*, terminal segments, male—all enlarged (author's illustration).

Male, more slender, head longer and tapering somewhat toward the front. (See fig. 108.)

Egg, as seen in the body of adult female specimen, is elongate oval.

Length, 0.75 to 0.90; head, 0.13 to 0.16; thorax, 0.10; abdomen, 0.50 to 0.60 mm. Width, 0.28 to 0.33; head, 0.10; thorax, 0.13 to 0.15; abdomen, 0.28 to 0.33 mm.

This species approaches the *acanthopus*, resembling it in the form of the sternal plate, the character of the legs, and the general form of the body. It differs, however, in having the sternal plate less narrowed posteriorly, more obtuse, or even truncated in front; more decidedly still in the form of the head, which is longer and less excavated for the insertion of the antennæ. It is also smaller, and the egg, if we may judge by what we can see through the walls of the female, is more elongated.

It has been collected from the white-footed or deer mouse (*Hesperomys leucopus*) at Ames, Iowa.

LOUSE OF THE GROUND SQUIRRELS AND CHIPMUNK.

(*Hæmatopinus suturalis* Osborn.)

Body short, broad; color, golden yellow.

Head oval, rounded and deflected in front; a large chitinous ring inclosing the base of the rostrum; a very distinct transverse suture behind the antennæ; sides slightly convex; lateral angles obtuse, without hairs; posterior angle acute, and passing well back upon the thorax; antennæ simple, located anterior to the middle of the sides; joints nearly equal in size. Thorax short, convex at sides, widest behind, sternal plate nearly circular, surface roughened; anterior and middle legs slender and nearly equal in size; claws slender and sharp; posterior legs very thick, claw strong and broad. Abdomen short, ovate, broadest near the front, sutures inconspicuous, hairs long; some of those on sides and posteriorly very long. Males and females are very similar, and distinguishable only by genital armature of male.

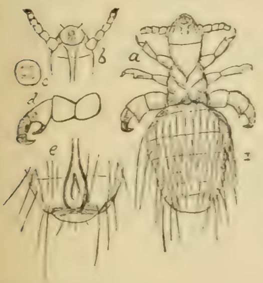

FIG. 109.—*Hæmatopinus suturalis*: *a*, dorsal view; *b*, head; *c*, sternal plate; *d*, posterior leg; *e*, terminal segments, male—all enlarged (author's illustration).

Length, 0.75 to 0.80; head, 0.27; thorax, 0.13; abdomen, 0.45 to 0.48 mm. Width, 0.35 to 0.40; head, 0.13; thorax, 0.18; abdomen, 0.35 to 0.40 mm.

This species is particularly well marked by the general form of the body and especially by the conspicuous transverse suture back of the antennæ. It differs further from most of the species in the genus in having both the anterior and middle legs slender and of nearly the same size, while the posterior legs alone are especially modified as clasping organs.

Although we have not seen Middendorf's description and figure of *H. læviusculus* from *Spermophilus eversmanni*, there can be scarcely a possibility of this being identical with it, since this differs in almost every particular as compared with the diagnoses of that species given by Giebel and by Piaget. We therefore describe it without hesitation as a new species.

It has been found plentiful on *Spermophilus franklini* and *S. 13-lineatus* at Ames, Iowa. An immature specimen from *Tamias striatus* presents the characters of the species so plainly that there can be little doubt that it is identical.

Hæmatopinus erraticus n. sp.

Approaches *Hæmatopinus hesperomydis.* Abdomen broad, middle and hind legs larger than front. Sternal plate circular incised at sides behind and produced medially. Head nearly as broad as long, rostrum slightly produced. Antennæ large, first joint thick, second longest. Fore legs rather small, middle legs considerably larger, hind legs largest. All tibiæ widened, front tarsal claw sharp, middle and hind claws broad, flat. Sternal plate rather wide, circular in front, slightly sinuate at sides, excised behind for insertion of posterior coxæ. Median portion produced, subtruncate, reaching about halfway between hind coxæ. Abdomen broad, lateral margins rather broadly corneous, disk with stiff hairs.

From "Larus bonapartii" in the Burnett collection. This reference seems very doubtful as the actual host of the species, and I suspect that it was taken from the gull after contact with some other animal in a game bag or otherwise. It seems to come most nearly to the type infesting rodents and family Muridæ, and I would predict that the species will be found on some mammal, probably a rodent. If actually parasitic on Larus it is a remarkable exception to the rule for Pediculidæ and should be regarded, I think, as a form, but recently established on an avian host and derived from a mammal-infesting species.[1]

A REMARKABLE PEDICULID PARASITE OF THE MOLE.

While these pages have been passing through the press, I have encountered upon a mole, *Scalops argentatus*, collected at Ames, Iowa, a very peculiar species of pediculid, and in order to bring it to notice in connection with the other species described here, I give a brief diagnosis of its distinctive features. It differs so decidedly from typical species of Hæmatopinus in characters given generic value that it will have to be placed in a new genus or else form a subgenus and the characters of Hæmatopinus be enlarged. I will call it Euhæmatopinus nov. gen.

Antennæ three-jointed; posterior pair of legs greatly modified and bearing on the femora and tibiæ stalked, disc-shaped appendages, projecting at right angles from these parts.

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[1] After the above paragraph was written I found slides of the same species from *Pteromys volucella*, where it was mounted with one female specimen of *H. sciuropteri*, and also specimens from *Arvicola pennsylvanica* and *Sciurus striatus*.

Euhæmatopinus abnormis n. sp.

Head nearly twice as long as broad, the anterior portion narrowing to a blunt point and the posterior portion scarcely longer than wide—nearly quadrate, slightly narrowing behind. Antennæ three-jointed, the first joint large, articulate with anterior half of head; second and third joints equal in size; the third as long as first and nearly twice as long as second, and having on its apical end a slight constriction, which in some specimens appears almost like an indistinct joint.

Thorax wider than long, broadened behind; sternal plate rounded in front, excised slightly at sides and produced behind into a strong spur, ending in a sharp point, which rests between the hind pair of coxæ. Anterior and middle legs of the usual type; the middle a trifle larger than the front; the posterior pair greatly modified, shortened, thickened, and incurved apparently incapable of being fully extended and hidden from above by the margin of the abdomen, so that the insect appears to have but four legs instead of six. The femur and tibia are each provided with a stalked appendage which extends at right angles from the exterior margin and consists of a short stalk bearing a flattened, circular, disc-like structure. These discs may evidently be opposed to the abdomen or to the tibiæ of middle legs and serve as clasping organs.

Body much depressed, sides of abdomen subparallel. Length 1.40 mm., width of abdomen 0.65 mm.

Hæmatopinoides Osborn.

Antennæ composed of three joints, terminal joint deeply excavated on the posterior side; abdominal segments at lateral margins broadly chitinous, with a strong tubercle and a semicircular plate above and below lapping over the chitinous portion of the succeeding segment.

Sucking Louse of the Pocket Gopher.

(*Hæmatopinoides squamosus* Osb.)

Body oblong, broadly flattened; general color, dark yellowish. Head small, longer than broad, narrowly rounded in front, widening behind the antennæ; lateral angles rounded, posterior margin acutely pointed beneath, with two large hairs set between the bases of the antennæ and directed outward; antennæ composed of but three joints, these being nearly equal in size, the first short, stout; the third longest and with a deep excavation on the posterior side. Thorax small, broader than long, margin irregular, sternal plate obtusely angled in front; lateral margins parallel, passing by obtuse angles into an acutely angled posterior extremity; immediately back of the sternal plate are two irregularly triangular chitinous plates, occupying the region of the metathorax and extending each side so that their bases reach to the bases of the coxæ. Anterior and middle legs of nearly the same size; hind legs larger, stouter, and better fitted for clasping. Abdomen large, oblong or elliptical, broadening very rapidly at base and terminating abruptly; lateral margins of segments broadly chitinous, a strong tubercle directed posteriorly and a semicircular plate above and below lapping over the chitinous portion of the succeeding segment, spiracle located at middle of lateral margin; median portion membranous, appearing minutely squamous. The

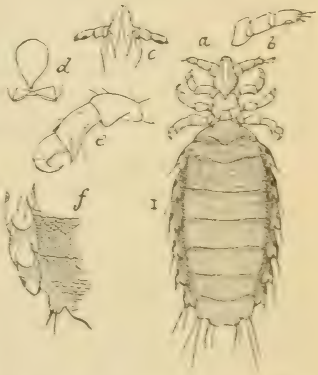

FIG. 110.—*Hæmatopinoides squamosus*: *a*, female dorsal view; *b*, antenna; *c*, head; *d*, sternal plate; *e*, posterior leg; *f*, border of abdomen—all enlarged (author's illustration).

sutures of the segments faintly indicated, a few long hairs scattered over the median portion of the dorsal surface, two hairs on each lateral tubercle, these much elongated on segments 6 and 7; the eighth with a tuft of hairs.

Length, 1.20; head, 0.27; thorax, 0.13; abdomen, 0.87; antennæ, 0.10 mm. Width, 0.50; head, 0.13; thorax, 0.20; abdomen, 0.50 mm.

This species departs so remarkably from others of the group that it seems necessary to erect for it a new genus. The most important characters and those which seem of generic value are the three-jointed antennæ and the semicircular plates on margins of the abdomen. The sternal structure is also different. In general aspect, however, it approaches the genus Hæmatopinus.

Two specimens, both females, collected from the pocket or pouched gopher, *Geomys bursarius*, at Ames, Iowa.

The Elephant Louse.

(*Hæmatomyzus proboscideus* Piaget.)

This louse, infesting the elephant, is about as exceptional in its way as the animal which harbors it. It appears to be of quite recent notice, though it is not unlikely that it has been known in countries where the elephant has been domesticated for an indefinite length of time.

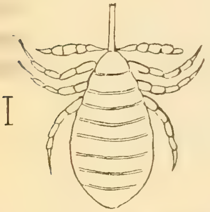

Fig. 111. — *Hæmatomyzus proboscideus* — enlarged (after Murray).

It was described by Piaget (Tijdschr. voor Ent., 2d series, IV, 254) in 1869, under the name of *Hæmatomyzus elephantis*. The same author, however, in his elaborate monograph, *Les Pédiculines*, changes the name to *H. proboscideus*. This louse differs from the others of the family in having a slender prolonged snout extending in front of the head. The antennæ are located at the base of this snout, and, according to Murray, are lenticular in form. In Piaget's figure, however, they appear of nearly equal thickness. "Color reddish, madder brown, smooth, shining, impunctate" (Murray).

The Louse of the Harbor Seal.

(*Echinophthirius setosus* Lucas.)

This louse was collected in considerable numbers from a seal in the aquarium at New York last year (1895). Specimens forwarded to me by Professor Bean were accompanied by the statement that they were infesting the harbor seals there and it was feared they would prove troublesome. Later it was stated that they almost entirely disappeared during the molting of the animals.

The species is distinguished by having the body covered with numerous small spines, and the antennæ are but four jointed.

CHAPTER V.

SUBORDER MALLOPHAGA.

Bird Lice.

This group embraces all the biting lice infesting birds and mammals. They are very distinct, indeed, from the preceding group, although frequently placed with them under such unnatural divisions as Anoplura, Pediculines, etc.

Their bodies are usually hard and horny and much flattened. They possess mandibulate mouth parts adapted to cutting and biting the hairs, feathers, epidermal scales, or excretions on the bodies of their hosts. They are said also to have a suctorial organ by means of which they may at times draw blood from the host animal. The mandibles are situated in most forms underneath the head and near the center, the clypeus projecting and forming the most anterior portion of the head. The labrum is present and the maxillary palpi are prominent in a part of the group. The eyes when visible are located back of the antennæ. The antennæ are five-jointed except in Trichodectes. The thorax is generally narrow and frequently but two divisions are apparent. The legs are adapted to clasping (Philopteridæ) or to running (Liotheidæ), the tarsi in the first case being short and fitted for folding against the tibiæ, and in the second case being long, well adapted to running, and provided with two claws. The members of the first division occur on both mammals and birds, those of the second, except Gyropus, are limited to birds. Wings are entirely wanting, and the abdomen contains nine or ten segments and is usually oval in shape.

In life history this group agrees with the preceding. The eggs are glued to the hairs or feathers of the host animal and open with a circular cap or lid at the free end. The larvæ are less flattened, shorter in proportion, and without the hardened parts common to the adults covering a part or all of the surface. The length of life and rapidity of multiplication has not been determined for any species so far as we know, and the habits of the insects make any such determination a matter of great difficulty.

While it is, of course, very desirable that a more complete knowledge of the life history of the species be secured, it may be considered as already established that all the species, with no known exception, pass their transformations on the body of the fowl, and that, unlike the mites, they may be attacked with the assurance that eggs and newly-hatched young are not developing in some out-of-the-way corner.

Moreover, the observations made on the length of time required for the hatching of the eggs indicate that they require a number of days at least, so that in repetition of treatments intended to kill individuals hatched since a former treatment a period of ten days to two weeks may be counted on as probably short enough.

Even were we able to keep the eggs under suitable conditions and determine its exact period of incubation for all the species, we would not know that this would hold for all times of the year, nor could we assume results as to the number of eggs laid by one female and length of life of the mature louse to be uniform under all conditions. For practical purposes, therefore, it will be best to work on the facts already known, using, where possible, measures that will destroy eggs attached to hairs or feathers as well as the lice, and to discriminate between the lice and the mites or ticks which breed away from the fowls, and must therefore be fought with a little different principle in mind, though often the same measures may be adopted for both.

It should always be borne in mind that lice must grow from eggs laid by the adult louse, and can never originate from filth or other matter. Chickens hatched in an incubator should be absolutely free from lice and remain so until brought in contact with a lousy hen or put in a lousy house.

The effect of these lice may be less important than the suctorial lice or the sucking ticks or mites; but judging from the serious results following the efforts of the animals to rid themselves, and from the known irritation due to anything crawling among the hairs or feathers, it can not be doubted that they cause much annoyance and inconvenience to the creatures that become their involuntary supporters.

A writer in the Poultry World gives the following statement as to the symptoms of lice in fowls:

> Bowel disease in summer is a sign of lice; the sleepy disease, in which the chicks are sleepy or drowsy, is a sign; refusal to eat; puny-looking body and slow growth; sudden deaths; gradual wasting away; constant crying; loss of feathers on the head, and other symptoms that appear surprising or remarkable. Even in the cleanest of houses, when not a sign of lice can be seen, look on the chick for the large lice. Not only on the chicks, but the large body lice are nearly always on the adults. A chick will never get lousy unless the old fowls are near, and that is why brooder chicks grow faster than those under hens. The large lice will kill ducks suddenly. They kill nearly all the young turkeys that die. Whenever you notice a sick fowl dusting itself look for lice. No doubt a majority of our readers fully understand how to get rid of lice, but the fact is that they will not believe that lice are present, and ascribe the results of the work of lice to some disease, thus doctoring the birds unnecessarily. First, we wish to say that while you may easily discover myriads of little red mites in the poultry house, yet the real enemy is the large gray body louse which works on the heads, necks, and vents, and which never leaves the birds. To find this louse a very close search must be made, as he lurks down on the skin, at the base of the feathers, and hides from view. A single one of these voracious fellows on the head or throat of a young chick will sometimes cause the chick to droop and die.

Mr. E. W. Parker, in Poultry World, gives a good idea of how indifferent one may be. He says:

> In July and August especially (but at all times of the year) lice abound more than at any other time, and chicks will become infested with them unless great care is taken. Many persons wonder why their young chicks droop and die, mope around for a week or two, all the time getting thinner and weaker, finally become unable to stand, and die—these persons claiming all the time that "lice is not the cause of it" because they have searched under the wing for the red or yellow louse, on the head for the large head louse, and in fact have looked them from top to bottom for parasites and have found none. I wonder if they have ever looked on the throat, or at the side below the ears, for the large head louse. I wonder if it entered into the brain of such breeders that the head louse could destroy the life of chicks from two to six weeks old by sucking the lifeblood from the throat and under the head. If it has not, I can tell them that such is the case, and I say without fear of contradiction that when the chick appears weak, growing weaker and thinner, the skin seems to shrink upon the body, and there is a slimy discharge from the body, and when the chick eats it is usually with difficulty, and as the supposed disease advances it seems almost impossible for the chick to swallow, finally refusing to eat; when any or all of these symptoms appear then examine the underpart of the head and the throat and at the sides for the head louse, and nine times out of ten he will be found snugly at home among the down or sprouting feathers; then apply two-thirds glycerin, one-third carbolic acid, and five times as much water as the above mixture.

The order may readily be separated into two families upon characters a part of which have already been mentioned, namely, the structure of the mouth parts and the feet. The latter, which is the most readily observed, can be easily told from the mode of locomotion, the members of the first group being incapable of rapid movement, but well adapted to clinging to the hairs or feathers, the latter running freely and swiftly, but having less power to clasp.

Family PHILOPTERIDÆ.

Infesting horses, cattle, sheep, dogs, cats, chickens, turkeys, pigeons, ducks, etc.

The members of this family have the mouth parts on the under side of the head. Mandibles strong; maxillæ wanting; tarsi short, of one or two joints, the claw meeting a tooth at the apex of the tibia; mesothorax apparently wanting; abdomen having nine segments.

The group is a large one, the species being so numerous that there is scarcely a bird but harbors one, and sometimes several, species of this family.

The genera are, for the most part, easily separated; Docophorus, by the presence of a movable appendage (trabecula) in front of the antennæ; Nirmus, by the presence of an immovable tooth in front of the antennæ and the generally entire terminal segment of the abdomen of the female. Goniocotes and Goniodes are robust forms, usually with large heads strongly curved in front. They differ by the former having simple antennæ in both sexes, while in the latter they are modified in the male. The former are also usually much the smaller. In Lipeurus the body is generally long and slender, the antennæ of the males large and often with a complicated structure, while the terminal segment of the female is bilobed. The species of *Ornithobius* are white or transparent and especially characterized by having sharp curved appendages meeting in front of the clypeus. *Trichodectes* is at once known by the three-jointed antennæ. Other genera of the family do not contain species infesting domestic animals, and hence need not be noticed here.

LOUSE OF DUCKS AND GEESE.

(*Docophorus icterodes* Nitzsch.)

This species has been recorded from so many different members of the order of birds containing the ducks and geese that it may be considered as common to the order. It was described by Nitzsch in 1818, and has been mentioned by most writers on parasites since that time. It is about 1 mm. in length, and has the head and thorax of a bright reddish color with darker bands. The abdomen is white in the center, with broad, dark reddish, horny bands at the sides, with a darker spot at the margin. It occurs commonly on our native ducks.

LITTLE RED SWAN LOUSE.

(*Docophorus cygni* Denny.)

Notwithstanding the apparent abundance of this species, it does not appear to have been described before 1842, when it was described and figured by Denny (Monog. Anop. Brit., p. 95, pl. 1, fig. 1), but according to this author it was figured by Redi (Exper., Pl. IX, fig. inf.), which would carry its recognition back two hundred years. It is common on both the wild and domesticated swans, and Denny states that he has received it from the bean goose.

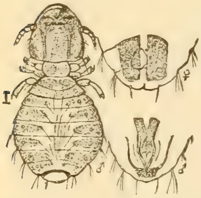

FIG. 112. — *Docophorus cygni* (author's illustration).

It is 1 mm. in length, of a robust form, the head decidedly rounded in front, except at the extreme tip, where it is slightly excavated. In color the head, thorax, and legs are bright reddish brown, while the abdomen is white in the center and dark brown at the sides, the brown occupying hard plate-like portions at the side of each segment.

The form and the distribution of these plates are shown in the accompanying figure.

LESSER CHICKEN LOUSE.

(*Goniocotes hologaster* Nitzsch.)

This common species which lives upon the domestic fowl was recognized by DeGeer and by Nitzsch. It has been generally confused with another form, or rather another larger and perhaps more common form has been generally accepted by English and American writers as the *hologaster*, this being due to the description and figure given by Denny, who does not seem to have seen the true *hologaster*, but described for it, according to Piaget, an immature specimen of the larger species since described as *Goniocotes abdominalis* Piaget.

The *hologaster* is only about 1 mm. in length, whereas the *abdominalis*, or Denny's *hologaster*, is about 3 mm. In general form the species are somewhat similar, the *hologaster* being less constricted at the thorax and more regularly tapering to the end of the abdomen. The head is more nearly quadrate; the abdomen not so conspicuously marked, the incurved margins of the segments not extending so decidedly upon the disk and presenting the distinct lines seen as a border to the fasciæ in *abdominalis*.

LARGE CHICKEN LOUSE.

(*Goniocotes abdominalis* Piaget; = *G. gigas* Taschenberg.)

This is probably fully as common as the preceding species. As already stated, it is the form which has been commonly referred to in English and American works as the *Goniocotes hologaster*, which doubtless accounts for its not having been described until quite recently.

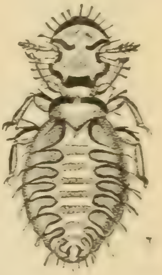

FIG. 113.—*Goniocotes abdominalis* (after Denny).

It is a large, conspicuous species, about 3 millimeters in length, quite broad, the head nearly circular in front and constricted behind, the thorax small, the abdomen widening to near the end and terminating abruptly. The head, thorax, and legs are yellowish, with dark margins and spots; the abdominal segments bear lateral whitish fasciæ bordered with black.

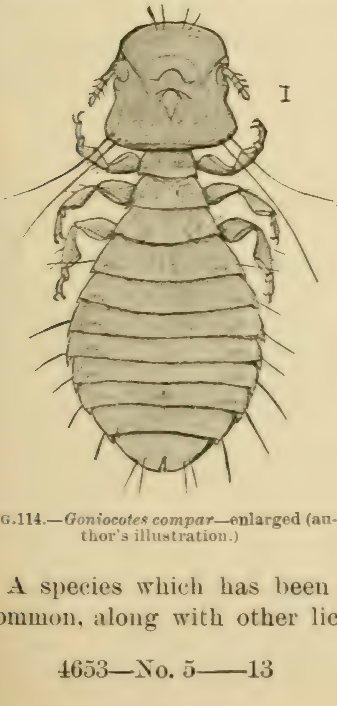

FIG. 114.—*Goniocotes compar*—enlarged (author's illustration.)

It appears to be much less common than some other species of chicken lice, notably *Menopon pallidum* and *Lipeurus variabilis*.

PIGEON LOUSE.

(*Goniocotes compar* Nitzsch.)

A species which has been familiar for a long time and generally common, along with other lice, on domestic pigeons. It is a rather small-sized species, a little more than a millimeter in length. The head is rounded in front, narrower between the antennæ, broadest near the posterior margin. The thorax is narrower, the abdomen in the male broadest near the posterior end and squarish behind; in the female more regular and broadest near the middle. It is whitish, with a rather broad brownish margin, from which prolongations extend inward upon the sutures.

THE PEACOCK GONIOCOTES.

(*Goniocotes rectangulatus* Nitzsch.)

This species, which shares with the *Goniodes falcicornis* the hospitality of the peacock, was first described by Nitzsch (Germar's Mag., III, 294). It is a small species, about the size of the *hologaster*, which it resembles quite closely. The head is squarish, somewhat rounded in front, while the thorax and abdomen are short and oval. While less noticeable than the larger species associated with it, it is probably no less abundant.

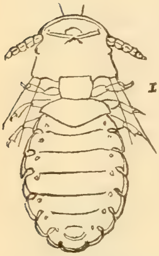

FIG. 115.—*Goniocotes rectangulatus*—enlarged (after Piaget).

GONIOCOTES OF THE PHEASANT.

(*Goniocotes chrysocephalus* Giebel.)

This parasite of the pheasant was first described by Giebel in 1866 under the name of *Goniocotes colchici*, which he afterwards changed to the above. It is said to resemble the *hologaster* which affects the domestic fowl. It has not been recorded from America, but will probably be found on imported birds.

BURNETT'S GONIOCOTES.

(*Goniocotes burnettii* Pack.*)

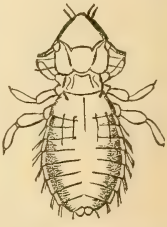

FIG. 116.—*Goniocotes burnettii*—enlarged (after Packard).

A species described by Dr. A. S. Packard (Am. Nat., Vol. IV, p. 94) is apparently much less common than some of the other species common to the sadly infested barnyard fowl. According to Dr. Packard's description, it differs from the *G. hologaster* of Europe, which lives on the same bird, in the short second joint of the antennæ, which are also stouter, and in the long head, the clypeus being much longer and more acutely rounded, while the head is less hollowed out at the insertion of the antennæ. The abdomen is oval and one-half as wide as long, with transverse, broad, irregular bands along the edges of the segments. The mandibles are short and straight, two-toothed. The body is slightly yellowish and variously streaked and banded with pitchy black. This proves to be a *Lipeurus*, or at least it agrees with *L. heterographus* in most particulars. Occurs also on ducks. (See *L. heterographus*, also technical notes.)

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* Probably identical with *Lipeurus heterographus* Nitzsch. (See p. 231.)

The Chicken Goniodes.

(*Goniodes dissimilis* Nitzsch.)

Although this species has been known for a considerable time, it seems not to have been abundant enough to receive frequent notice.

Denny says:

> I suspect this species of being of rare occurrence, as the only specimen which I have examined was communicated by Mr. Thompson from Belfast, and that being a female I am precluded from describing the characteristics of the male.

It is a large species, 2 to 2½ mm. in length, and Denny describes it as tawny in color, smooth, shining, and pubescent, with large subquadrate head, a short transverse prothorax, and a large abdomen with the side markings confluent, and the sutures with deep chestnut bands. It has not as yet been recorded for this country that we are aware of, though in all probability it occurs here as well as in Europe.

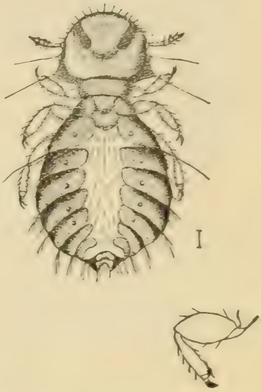

Fig. 117.—*Goniodes dissimilis*—enlarged (after Denny).

Guinea Fowl Goniodes.

(*Goniodes numidianus* Denny.)

We have only the record given by Denny (Monog. Anop. Brit., p. 163, Pl. XIII, fig. 7) as authority for this species. His diagnosis of the species is as follows: "Pale straw-yellow, shining and smooth, margined with black; head suborbicular; abdomen acuminate, with pitchy brown, interrupted transverse bands." He states that "the only specimens of this species I have seen are two males, which I took from off a pintado (*Numida meleagris*)." We have not had the opportunity to search for this species and can not say whether any effort has been made in this country to obtain parasites from the guinea fowl. It is most likely that a careful examination of a number of the fowls would furnish examples of this species and possibly still others not yet recognized.

The Pigeon Goniodes.

(*Goniodes damicornis* Nitzsch.)

According to Giebel, this species was first described by Nitzsch, and his reference is "Zeitschrift f. ges. Naturwiss., 1866, XVII, 119." It is a rather large species, a little more than 2 mm. in length and of a bright-brown color. The head is very much rounded in front and strongly angular behind. It occurs only on pigeons, but upon these appears to be rather common, though not yet met with in our own collecting.

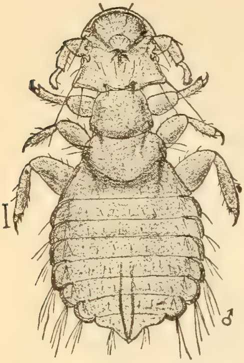

FIG. 118.—*Goniodes damicornis*—enlarged (author's illustration).

THE LITTLE PIGEON GONIODES.

(*Goniodes minor* Piaget.)

Piaget (Les Pédiculines, p. 256) has described as a distinct species, under the above name, a form quite similar to the preceding but smaller and presenting some differences of the antennæ and form of the head. According to this author, it is found on the domestic pigeons and also on *Columba tigrina*, *C. risoria*, and *C. bitorquata.* It has not to our knowledge been recorded in this country as yet, but is likely to be found along with the other forms.

LOUSE OF TURKEY.

(*Goniodes stylifer* Nitzsch.)

Nitzsch describes this species in Germar's Magazine (III, 294), and it has been frequently mentioned since that time. It was also described by Schrank under the name of *Pediculus meleagris* (Faun. Ins. Aust., 504). It is a large species, 3 mm. or more in length, and quite readily distinguished from other common species by the hind angles of the head, which are extended backward into long styles, from the ends of which extend strong bristles. The thorax is angular, with a black margin, and the abdomen is pale, with transverse bands of dark color.

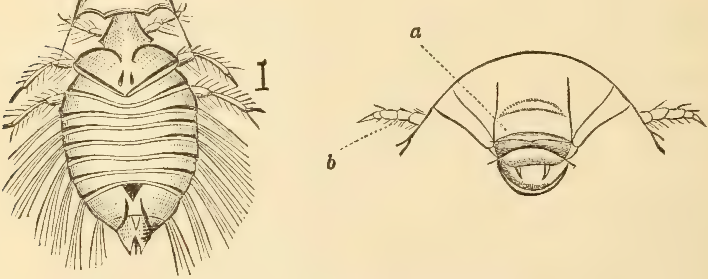

FIG. 119.—*Goniodes stylifer: a*, mouth parts; *b*, antennæ—enlarged (after Cuvier).

The species probably has a distribution equal to that of the turkey itself, and with the other species common to this fowl render it pretty thoroughly infested.

THE PEACOCK GONIODES.

(*Goniodes falcicornis* Nitzsch.)

This large and common species appears to have been first recorded by Redi, who figured it under the name of *Pulex pavonis*. Since that time it has engaged the attention of Linnæus, Frisch, Olfers, Fabricius, Stephens, Schrank, Nitzsch, Burmeister, Stewart, Panzer, Denny, Giebel, Piaget, and numerous other writers, who have described, figured, and discussed it under one name or another, from which we would infer that it must have been one of the most common and frequently met with of any of the parasites of our domesticated fowls.

It is a large species, 3 to 4 mm. in length, of a bright reddish-yellow color, with a large head, the hind angles of which are acute and prominent. The first joint of the antenna in the male is large and bears a prominent tooth. The abdomen is broad, light yellow, with prominent transverse lateral bands extending nearly to the middle line. It has been taken repeatedly in America.

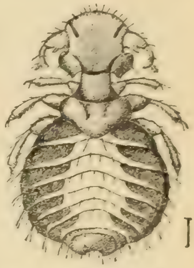

FIG. 120.—*Goniodes falcicornis*—enlarged (after Denny).

THE PHEASANT GONIODES.

(*Goniodes colchicus* Denny.)

This species is not likely to prove of any special interest in this country, except where pheasants have been introduced, and we will simply mention it and repeat the diagnostic description given by Denny:

> Bright chestnut-yellow; head subquadrate, temporal angles obtuse, thorax with a broad ferruginous margin; abdomen pale, yellow-white, nearly orbicular, each segment, excepting the first and last two, with a pitchy black arcuate fascia.

He refers this species to the insect mentioned under the name of *Pediculus phasiani* by Fabricius, with a question as to their identity.

Goniodes gigas Tasch (?).

Professor Comstock, in his Introduction to Entomology, first ed., Pt. I, p. 86, names this as a parasite of the hen, but he states no authority for the species, and we are unable to find any other reference to it, unless it be intended for *Goniocotes gigas* Taschenberg.

LIPEURUS OF THE CHICKEN AND PHEASANT.

(*Lipeurus heterographus* Nitzsch.)

This species, first recorded by Nitzsch, would appear from the writings of European naturalists to be rather common, but it has seldom been taken in this country, a fact which may be due to the little attention that has been given to collecting these insects here, rather than to their absence.

I have taken it from the chicken at Ames, Iowa, and from the characters which it presents I believe that Packard's *Goniocotes burnettii* was described from a female of this species.

According to the figures given by Piaget, it differs decidedly from the *variabilis*, with which it is most likely to be confused, in having the head rather narrowed in front instead of inflated, and the body is much stouter.

Besides occurring upon the common domestic fowl it is said to occur upon pheasants of certain species.

GUINEA FOWL LIPEURUS.

(*Lipeurus numidæ* Denny.)

Denny described this species under the name of *Nirmus numidæ*, but Piaget refers it to the genus Lipeurus.

It is characterized by Denny as "livid yellow, shining and smooth; head subpanduriform, lateral margin black; abdomen with two fuscous interrupted dorsal fasciæ."

As he states that he found "two specimens," it would appear not to have occurred in great abundance.

LOUSE OF THE SHELDRAKE.

(*Lipeurus tadornæ* Denny; = *Lipeurus lacteus* Giebel.)

Denny described this species from specimens taken from the sheldrake, and cites also a manuscript name of Leach, *Ornithobius tadornæ*, which he assumes to be the same and which applied to specimens in the British Museum. The species was later described by Giebel with the name *lacteus*, though he at the same time quotes Denny's name without stating any reason for the change.

Piaget states that he prefers the name chosen by Giebel to that of *tadornæ* in order to avoid as much as possible the names of birds upon which the parasites have been found. If this principle were carried out it would involve the change of hosts of names applied to members of this group of insects, and as it is directly opposed to the well-established principle of priority we believe the name applied by Denny should be restored.

The insect is characterized by a milky-white color, the surface smooth and shining, the head, thorax, and abdomen with black marginal spots; it is elongate in form and the head heart-shaped.

Professor Comstock cites it as occurring also upon the goose, but upon what authority we are unable to say, as the authorities consulted mention it only as a parasite of the sheldrake.

THE PIGEON LIPEURUS.

(*Lipeurus baculus* Nitzsch.)

This is another of the species that was given a name and figure in the work by Redi more than two hundred years ago. It was also described briefly by Linnæus under the name of *Pediculus columbæ;* but since the description by Nitzsch in 1818, under the name of *Lipeurus baculus*, this has been the accepted name, and has been used by nearly all writers since that time.[1] It is not strange that it attracted the attention of early naturalists, as it occurs in wonderful abundance on almost every pigeon that may be examined, and its striking appearance, due to the extreme slenderness of the body, would at once catch the eye of the observer.

It is about 2 mm. in length, the body very slender; the head and thorax are of a bright reddish-brown color, while the abdomen is rather dusky, with a series of patches of a brown color corresponding with the segments of the abdomen.

So far as known, this species is confined to pigeons, and there seems no danger of their being transmitted to other fowls with which they may associate.

Piaget states that he has found the females astray upon a *Sula alba*, upon a *Totanus glottis*, and upon a *Charadrius minor*, only in the last case the appendages of the clypeus wanting; the last segment had the lobes more acute and the dimensions were less.

Denny described, under the name of *Nirmus claviformis*, what appears to be the young of this species, though he gives measurements for males and females, which would seem to indicate that he was able to see the sexual organs. In all the specimens we have examined that agree with his figure and description of this form we have been unable to discover the genital organs, which makes it appear that they are immature, and they are in all cases associated with the *baculus*, with which they seem to agree in all structural characters. The body is shorter, the markings less distinct, and the rudiment of a trabecula is more prominent than in the adults.

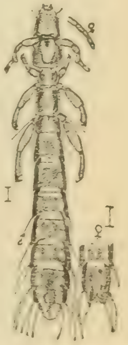

FIG. 121. — *Lipeurus baculus* — enlarged (author's illustration).

It seems best, therefore, at least till well-marked males and females can be found, to consider these as immature *baculus*.

Piaget does not discuss this matter, but in his index to "Les Pédiculines" he gives *N. claviformis* as a synonym of *L. baculus*.

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[1] Giebel names and describes two species, *bacillus* and *baculus*, referring both to Nitzsch, and placing under *bacillus* the form which all other authors refer to *baculus*, and referring to *baculus* a form not separated by other authors, but which he describes as different from the other form. It seems undesirable to add names without a more decided difference in form, and we agree with Piaget in uniting both under the old name.

THE SQUALID DUCK LOUSE.

(*Lipeurus squalidus* Nitzsch.)

According to Denny, this species was referred to by Fabricius under the name of *Pediculus anatis*, and it seems extremely probable that it was referred to under other names by many of the early writers, since it is so common on many species of ducks that it is hardly possible that it should have been entirely overlooked. The first definite reference to it, however, is the description by Nitzsch in 1818; and, more fortunate than some of the related species, this has been allowed to hold in all subsequent works, and so far as we know there are no synonyms for its specific name.

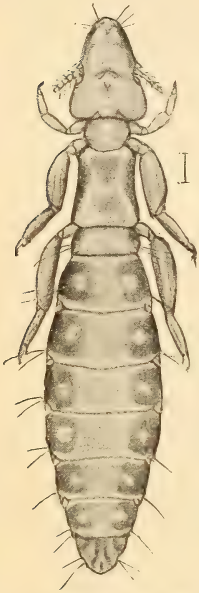

FIG. 122.—*Lipeurus squalidus*—enlarged (author's illustration).

It is a very abundant and common species and occurs on a great many different species of ducks, both wild and domesticated; indeed, so generally does it occur on the different species of the genus *Anas* and related genera that we may almost say that it is common to all species of the family including the ducks.

It is quite characteristic in appearance, and not likely to be confused with other species on the same birds. It is about 4 mm. (one-sixth inch) in length, elongate in form, and of a light yellowish color, with dark border to the head, thorax, and abdomen. On the latter this border is broken into a series of quadrate patches corresponding with the segments. The young lack the definite markings of the adults, but have nearly the same general outline of body. The annexed figure will doubtless enable anyone to determine with certainty as to specimens taken from ducks.

Lipeurus anseris Gurlt.

Under this head is recognized a species which is said to differ from the *anseris* of Linnæus and other authors, which is referred to *jejunus* of Nitzsch. It was described from specimens taken from the domestic goose, but would appear to be rather a rare species since it has not been generally recognized. We insert it upon the authority of Piaget, who seems to consider it as unquestionably distinct from related species, though apparently in doubt as to the real form from which the descriptions were made.

THE LIPEURUS OF THE GOOSE.

(*Lipeurus jejunus* Nitzsch.)

It is generally accepted that Redi had this species in hand as one of the different parasites which he figured, and it has certainly been referred to by Linnæus, Albin, Olfers, and others, but the description by Nitzsch may be taken as the first strictly technical description that would separate it certainly from related forms. Denny records it as taken from the white-fronted goose, the brent, the wild goose, and the bean goose, and Piaget adds the gray goose, Canada goose, domestic goose, and the *ægypticus*.

It is evident, therefore, that it is generally distributed upon members of the goose family.

We have not had specimens in hand, but it is described as slender, pale yellow-white, with a pitchy margin, the first eight segments of the abdomen with quadrangular bands, and the legs dusky above.

THE TURKEY LOUSE.

(*Lipeurus polytrapezius* Nitzsch.)

This, like the *variabilis*, appears to have been one of the earliest species to receive recognition, as Linnæus cites Redi (Exper., t. II, fig. 2) with the name *Pediculus accipitris*, while he himself uses the name *Pediculus meleagridis*, and gives a brief description, which probably refers to this species. Authors have quite generally, however, followed the name given by Nitzsch, as above. It has doubtless been common wherever this fowl has been kept and is one of the familiar species.

It is of rather large size, 3 to 3½ mm. (an eighth of an inch) in length, of an elongated form, having a pale, yellowish white color, and with a black margin around the body. The abdomen is long, and all the segments but the last are marked with a grayish brown trapezoidal spot on each side. According to Denny:

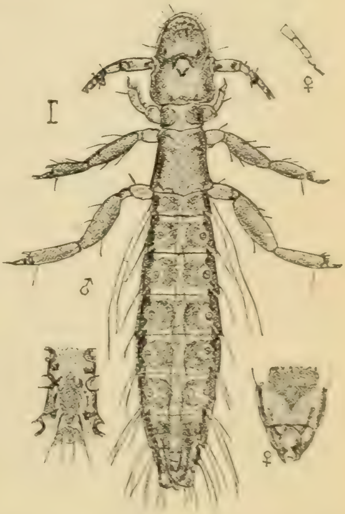

FIG. 123.—*Lipeurus polytrapezius* — enlarged (after Piaget).

> Their mode of progression is rather singular, as well as rapid. They slide, as it were, sidewise extremely quick from one side of the fiber of a feather to the other, and move equally well in a forward or retrograde direction, which, together with their flat, polished bodies, renders them extremely difficult to catch or hold. I have observed that where two or more genera infest one bird, they have each their favorite localities; for, while the *Goniodes stylifer* will be found on the breast and neck of the bird, the *Lipeurus polytrapezius* will be congregated in numbers on the webs and shafts of the primary wing feathers.

Very common on turkeys, and I have specimens from the wild turkey as well.

THE VARIABLE CHICKEN LOUSE.

(*Lipeurus variabilis* Nitzsch.)

This species appears to have been recorded as early as 1668 by Redi, later by Frisch, unless these both refer to *Menopon pallidum*, and to have received a brief description by Linnæus (*Fauna Suecica*, No. 1960) under the name of *Pediculus caponis*. The name by which it is now universally known, however, was given with description by Nitzsch in 1818 (Germar's Mag., III, 292). While no very extensive literature seems to have accumulated in reference to this particular species, it is of course included in the many articles referring to poultry lice in general. It does not seem, however, to be so abundant as some of the other species infesting the common domestic fowl.

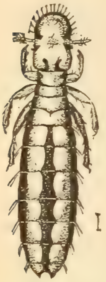

FIG. 124.—*Lipeurus variabilis*—enlarged (after Denny).

It is about 2 mm. (one-twelfth of an inch) in length, the body elongated, of a whitish color, and smooth and shining. The margins of the body are black; the head is large, rounded on the anterior margin, and the whole appearance sufficiently distinct from any of the species infesting the chicken, so that, with the aid of the figure, there can be no difficulty in distinguishing it at a glance. Denny says: "Common on the domestic fowl, preferring the primary and secondary feathers of the wings, among the webs of which they move with great celerity."

THE WHITE SWAN LOUSE.

(*Ornithobius cygni* Denny; *O. bucephalus* Giebel.)

This large and handsome species was quite certainly recognized by Redi and figured by him and has received frequent mention since. It is a conspicuous species, and appears to occur in great abundance on different species of swans, so that it is readily obtained. It has been recorded as occurring on the domestic and wild swan of the old world as well as the *musicus* and *bewickii*, and we have taken it in great abundance from the common swan of this country, probably the Trumpeter Swan.

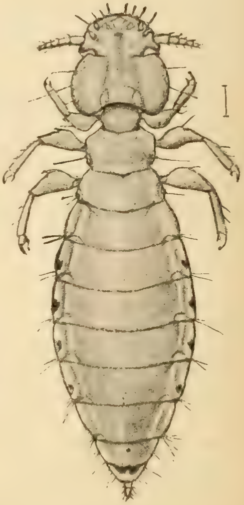

FIG. 125.—*Ornithobius cygni*—enlarged (author's illustration).

The body in this species is whitish, but so transparent that all the internal organs are easily seen through the body walls. There are black points at the outer hind margins of about four of the abdominal segments, as shown in the figure, and the last segment in dusky or nearly black. It is 4 mm. long (one-sixth of an inch), and the body is rather slender and decidedly flattened. Altogether this species seems to be almost as beautiful and as graceful in its movements as the bird which harbors it. Some of the specimens we have secured appear to contain blood, and while these parasites are not supposed to extract blood from their hosts, it is possible that they may at times burrow deep enough to secure access to the capillaries or feed upon blood that may have exuded from wounds upon the surface of the body of the bird.

The Louse of the Cat.

(*Trichodectes subrostratus* Nitzsch.)

While it is possible that this parasite was referred to by Otto Fabricius about the year 1780 under the name of *Pediculus canis*, the first certain reference to it appears to have been the description by Nitzsch in 1818. Since that time it has been referred to by nearly all writers on the common parasites of animals, but so far as we know there has been no special description of the different stages, and we must assume that there is no important departure from the habits of species that are more thoroughly known.

It is a little more than a millimeter in length, and has much the appearance of the species occurring on other domestic animals, but is distinguished particularly by the form of the head, which is quite pointed, and the under part of the front of the head is hollowed out in a furrow about the size of a hair. The insect will often be found adhering by the mouth parts with a hair so closely held in this groove that it is somewhat difficult to tell where the hair begins as separate from the insect.

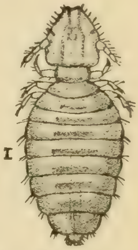

FIG. 126.—*Trichodectes subrostratus*—enlarged (author's illustration).

There is no record that we have seen that indicates its presence on any other animal than the domestic cat, and, judging by my own observation, it is only occasionally that cats become infested with it. When they do the usual remedies may be administered, especially a washing with kerosene emulsion, after which the animal should be allowed to dry in a warm place, as the fur is so fine that it dries slowly.

The Biting Louse of the Dog.

(*Trichodectes latus* Nitzsch.)

Something over a century ago DeGeer mentioned a species of parasite on the dog under the name of *Ricinus canis*, which probably referred to this species, and another mention by Olfers under the name of *Pediculus setosus* probably preceded the description by Nitzsch under the name which the insect has borne since 1818.

Probably everyone who has had much to do with dogs is aware to what an extent this parasite may multiply and how troublesome it is to this friend of man. It is generally believed that the lice are more troublesome to puppies than to old dogs, and it is not at all unlikely that the insects migrate when possible from older to younger animals.

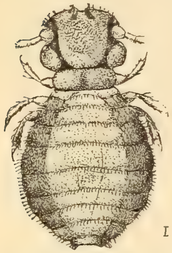

FIG. 127.—*Trichodectes latus* — enlarged (after Denny).

In color this species agrees pretty closely with the other species, and it is of about the same length as the cat louse, a little more than 1 mm., but it is much broader in proportion, being more than half as wide as long, and the head is short and the front but slightly curved.

THE LOUSE OF THE BEAR.

(*Trichodectes pinguis* Nitzsch.)

Inasmuch as the common brown bear has been to a considerable extent domesticated, and indeed furnishes a means of support to a certain class of people, it seems proper to introduce mention of its common parasite here. The species was described by Nitzsch, and apparently later authors have done little more than quote his description. To what an extent bruin suffers from the company of his guests we are not aware, but they probably multiply upon him as on other animals and cause him the same amount of annoyance.

It is described as characterized by the form of the head, which is subquadrangular. It is nearly 2 mm. in length.

THE LOUSE OF THE LLAMA.

(*Trichodectes breviceps* Rudow.)

In some parts of South America the llama is a very important domestic animal, and consequently this parasite has a place with the other species included in this work.

This species was described by Rudow in 1866, but as we have not seen specimens we must leave it with the mere mention. It is said to be 1 mm. in length, and doubtless agrees closely with the other species of the genus in appearance.

THE LOUSE OF THE GOAT.

(*Trichodectes climax* Nitzsch.)

Since this species was described by Nitzsch in the early part of the present century it does not seem to have received very frequent notice, and Denny does not appear to have found it in England.

It is described as having the head wider than long, quadrangular in shape, and the body in the female nearly two-thirds as wide as long, the length being about 1½ mm.

The *Trichodectes capræ* of Gurlt is considered by Piaget as identical with *climax*, while the *Tr. capræ* of Packard is not mentioned by him, but Professor Verrill has expressed the opinion that it is equivalent to *limbatus*, mention of which follows. It may be stated here, however, that the figure given by Packard agrees well with Piaget's figure of *climax*. It has been collected from goats at Baltimore by Dr. A. Hassall.

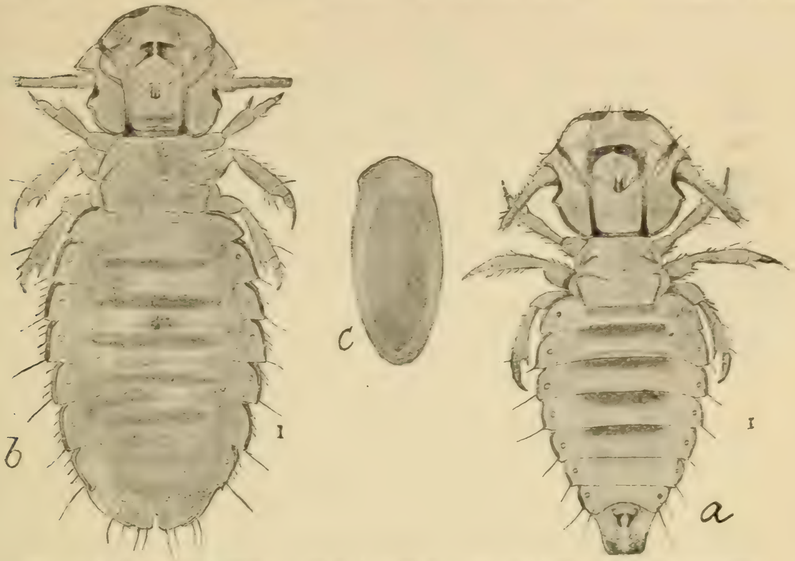

FIG. 128—*Trichodectes climax*: *a*, male; *b*, female; *c*, egg—all greatly enlarged (original).

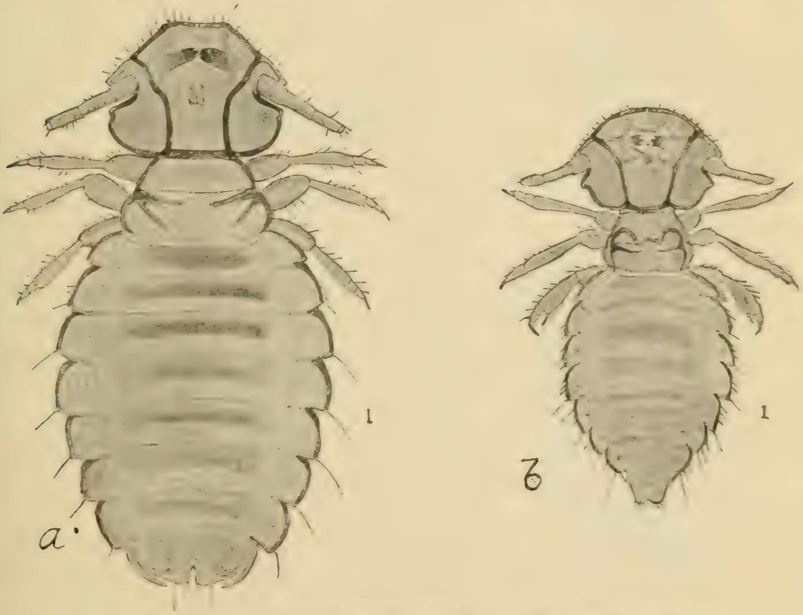

FIG. 129.—*Trichodectes limbatus*: *a*, female; *b*, male—greatly enlarged (original).

Trichodectes limbatus Gervais.

This species is referred to the Angora Goat, and is recognized as a distinct species by Giebel, Piaget, and others. It is the species to which Professor Verrill thinks Dr. Packard's *capræ* belongs. Dr. Packard does not state upon which species of goat he found his specimens, but it is probable that they were from the common species, and if so, and inasmuch as his figure agrees fairly well with *climax*, it would seem as likely to belong there.

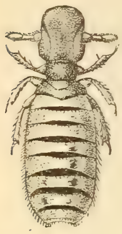

Fig. 130.—*Trichodectes sphærocephalus*—enlarged (after Denny).

In a recent bulletin from the Bureau of Animal Industry, Dr. Cooper Curtice describes these forms and endeavors to establish their specific identity. The principal points urged are a proportional difference in size between males and females, a difference in markings, and difference in size of eggs, but these are all variable, and the differences, as shown in the excellent figures accompanying the report, are so slight that we are the more impressed with the view that they are only varieties, and unless it be shown that they do not interbreed nor survive if changed from one host to the other we should be inclined to use the two names as synonyms.

The Louse of the Sheep.

(*Trichodectes sphærocephalus* Nitzsch.)

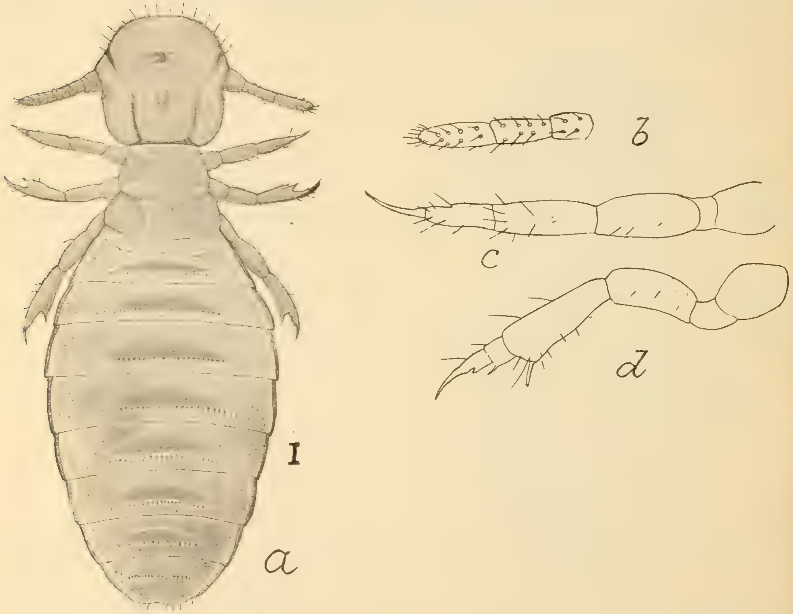

Fig. 131.—*Trichodectes sphærocephalus:* *a*, female; *b*, antenna; *c*, *d*, dorsal and side aspect of leg—all enlarged (original).

Redi is credited with the recognition of this species, and following him Linnæus described it under the name of *Pediculus ovis*, and later still it was described in detail under the name given above. Denny's reference to it would indicate it as rare in England. It is of rather rare occurrence, which may be considered as fortunate, for, if abundant, it would be rather difficult to contend with on account of the long wool of the host.

It has been fairly plentiful at Ames on sheep which came originally from Canada, and proved quite troublesome. Pyrethrum proved most useful in the long wool in winter.

The name indicates its characteristic feature, namely, the rounded head. The color agrees closely with the related species.

Where it occurs it will be the best plan to pay close attention to destroying them at the time of clipping the sheep even if they are but few in number, as at any other time the labor of making thorough applications for them is greatly increased.

THE BITING LICE OF HORSES, MULES, ASSES, ETC.

(*Trichodectes equi* auct.)

The original reference by Linnæus to the lice of horses and asses under the name of *Pediculus equi* most certainly refers to the common *Trichodectes* infesting these animals, but Piaget has reached the conclusion that this reference is to the form subsequently described by Giebel as *Trichodectes pilosus*, and that the form described by Denny as *equi*, and which has since almost universally been treated as the Linnæan species, was in reality a different insect from that described by Linnæus under the same name. He therefore describes this form under the name of *parumpilosus*. It is certainly somewhat confusing to be obliged to drop the familiar designation for so common a species, and were it not that this conclusion has been reached by one who is probably the highest living authority regarding these insects we should hesitate to introduce the change. The figures given by Piaget, however, leave no question that there is a decided difference between *pilosus* and *parumpilosus*, and it is equally certain that our common species belongs to the latter form; so, if there is no question as to Linnæus having the form *pilosus* in hand, we certainly have no right on technical grounds to apply the term *equi* to our common form. We will therefore introduce descriptions and comparisons of the two forms and adopt, for the present at least, and on the authority of Piaget, the names given in his Les Pédiculines.

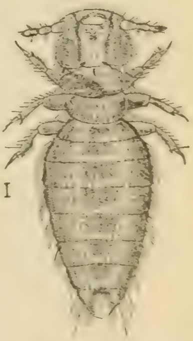

FIG. 132.—*Trichodectes pilosus*—enlarged (after Piaget).

Trichodectes pilosus Giebel.

This, according to Piaget, is the form originally designated by Linnæus as *equi*, and which, if that is correct, was the basis for a name which has been widely used to designate the biting lice of the members of the horse family. The original reference dates back considerably more than a century, and doubtless the insect was familiar many centuries before that, as the horse and ass have been too familiar as domestic animals to allow of the parasites common to them escaping entirely the notice of man.

According to Piaget this occurs upon both the ass and the horse, while the following species he has found only on the horse.

We have not been fortunate enough to secure examples of this form, though we have the other in great abundance, so we are compelled in describing to depend upon the excellent description and figures of Piaget, the latter being reproduced here for comparison. The head in this form is shorter and less rounded in front, that of the male being still less rounded than the female, while the abdomen is more slender and tapering. The transverse bands are also represented as less conspicuous. Perhaps the most striking point, however, is the position of the antennæ, which stand well forward on the head, so that the front border of the head and base of the antennæ are nearly in line.

The habits of the species and the remedies applicable to it are naturally identical with those of the other related species.

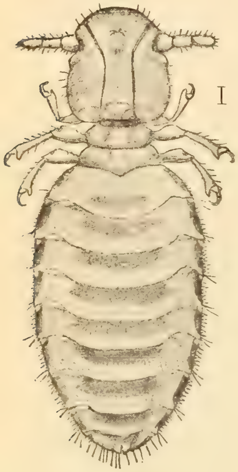

FIG. 133. — *Trichodectes parumpilosus* — enlarged (author's illustration).

Trichodectes parumpilosus Piaget.

While it does not seem possible that all the writers previous to Denny should have overlooked this form, which appears to be the more common one, at least on the horse, it may be true that Denny was the first to give it a thorough description and careful drawing. He speaks of it as common on the horse and ass, but Piaget says he has never found it on the ass, and there is of course a possibility that Denny did not distinguish between this and the preceding species.

In this species the head is decidedly rounded in front, the antennæ inserted well back, so that the head forms a full semicircle in front of the base of the antennæ. The abdomen is more slender and tapering than in *scalaris*, but less so than in *pilosus*, as shown in Piaget's figures.

The color is much the same as in the allied species, the head, thorax, and legs being a bright reddish brown, or chestnut, and the abdomen of a dusky yellowish color, with about eight transverse dusky bands occupying the central or anterior portions of the segments and extending from the middle line a little more than halfway to the margin. They are hardly as conspicuous as in *scalaris*, and apparently rather longer and more conspicuous than in *pilosus*.[1]

Piaget describes two varieties of this species, one from the Burchell's zebra (*Equus burchelli*) which he calls var. *ocellata* on account of a series of eye-like uncolored spots on the abdomen, and the other from the small horses of Java, var. *tarsata*, which has the second joint of the tarsi particularly developed, and which he mentions as in some respects approaching *pilosus*.

The habits of this species are well known and have received mention for many years. They seem to accumulate more particularly upon colts or horses in pasture, but their presence becomes most manifest in the latter part of the winter, when they may become so numerous as to cause great irritation to the animals infested. They occupy more particularly the region of the neck, and also accumulate around the base of the tail and between the legs, and the animals will frequently rub bare places in these regions in their attempts to rid themselves from the irritation.

It is unnecessary to give any special notice regarding treatment, as they must be attacked on the same plan as other species.

Even if it proves that this species does not ordinarily infest the mule or donkey, it would be policy not to allow these animals, if infested, to associate with horses, as we have no assurance as yet that they can not thrive on any members of the equine family.

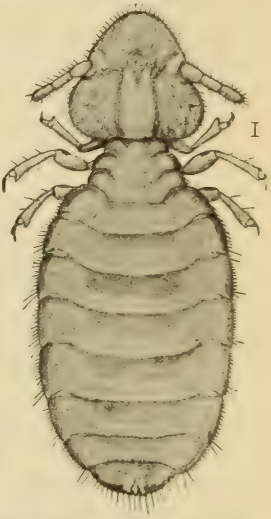

FIG. 134.—*Trichodectes scalaris*—enlarged (author's illustration).

BITING LICE OF CATTLE.

(*Trichodectes scalaris* Nitzsch.)

This species, which is a very abundant one upon cattle and occurs the world over, appears to have been first technically described by Linnæus (System. Naturæ, VII, p. 1017, No. 9) under the name of *Pediculus bovis*, and evidently the same species is referred to under the name of *Pediculus tauri* (*Fauna Suecica*, 1946). Notwithstanding these descriptions, both of which were under a different genus from that in which it is now placed, the species was again described by Nitzsch (Germar's Magazine, III, 296) under the name of *Trichodectes scalaris*, and it has been known by this name in all of the numerous writings subsequent to this description. It has been treated by all writers upon the parasites of animals and is one of the best known species of parasitic insects. The effects upon the cattle infested are often quite serious on account of their great number, but they are apparently less injurious than the suctorial species which infest cattle. This injury depends, of course, upon the numbers occurring upon the individual, and somewhat upon the irritability of the animal infested. This species much resembles the form occurring upon horses, but is somewhat shorter, and the abdomen tapers less toward the extremity; the dark bands across the abdomen are also more distinct. They are generally found in greatest abundance in the spring of the year, at which time adults and eggs are discovered in great numbers. Their development corresponds with the other species, and they are subject to the same methods of attack.

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[1] The hair line in the figure is about one-fifth longer than it should be.

They are very distinct from the suctorial species in appearance, and this difference is recognized by practical men, who speak of them as the "little red lice," as contrasted with the "blue lice," and they recognize, too, the difference in the trouble caused by the two species.

The application of kerosene emulsion or of tobacco decoction at seasons when this is practicable is effective, and we have found the process of fumigation described in the chapter on remedies to be effective. This, of course, is applicable at all seasons of the year, even in cold weather, without danger to the animal.

Family LIOTHEIDÆ.

LOUSE OF THE DOVE.

(*Menopon giganteum* Denny.)

This species of louse infesting doves is described by Denny (Anop. Brit., 225, f. 2, pl. 21). It does not appear to have been commonly observed since that time. A species is described under the name of *Menopon latum* (Piaget, Les Pédic., 457), which is probably the same as *Menopon giganteum.* As the species is evidently not a very abundant one, and the habits and remedies for this species are very similar to those for the *Menopon pallidum*, it is not necessary to enter into detail as to treatment. According to Denny, it is of a yellowish-brown color, shining, the head with a small brown patch on each side, the prothorax with a cruciform depression and the lateral margin reflected.

THE COMMON HEN LOUSE.

(*Menopon pallidum* Nitzsch.)

This species, probably the most abundant of all the lice infesting poultry, has been a familiar creature in the writings of entomologists, and also in all the literature of poultry raising.

It was evidently recognized by Redi (Exper., tab. 16, fig. 1), who figured it under the name of *Pulex capi.* Linnæus described it as

Pediculus gallinæ (Syst. Nat., 1020, 32), and it is also mentioned by Panzer under the same name. Olfers described it under the name of *Nirmus trigonocephalus*, and Nitzsch, recognizing its true generic relations, gave it the name of *Menopon pallidum*. While Denny, Giebel, and Piaget all agree in referring the figure by Redi to this species, Linnæus places it under his *Pediculus caponis*, which is equivalent to *Lipeurus variabilis* N.

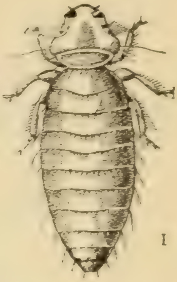


FIG. 135.—*Menopon pallidum*—enlarged (after Denny).

The annoyance that this one species causes poultry is probably equal to that of all the other species combined, for it occurs in great abundance, and almost every fowl examined will be found infested. Then, too, it passes readily to other species of birds, and many instances are recorded where horses kept near henroosts have been very seriously troubled by them. Some of these accounts seem hardly credible, taken in connection with the habits of the insect, and we are inclined to think that the worst cases, at least, may have been due to the presence of itch mites on the poultry and the migration of them to the horses, though in such case we should expect the fowls themselves to show more serious injury. It is, at any rate, important to keep lousy chickens away from horses.

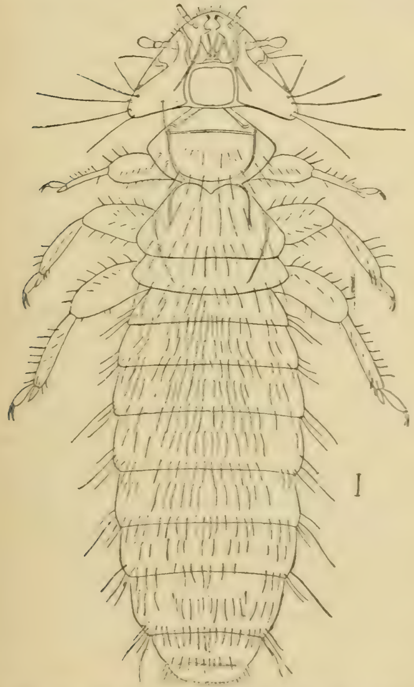


FIG. 136.—*Menopon biseriatum*—enlarged (original).

This louse is pretty easily distinguished from other common species infesting the hen by its light color and its great activity, running with great celerity among the feathers and from them upon the hands of persons holding fowls. It is from 1 to 1½ mm. in length, rather slender, and of a light straw-yellow color.

Remedies for this species must aim to reach the hiding places of the lice on the roosts and in the cracks of the walls of the henhouse as well as to destroy those on the fowl. Thorough fumigation and whitewashing, with careful attention to cleanliness, will do much to keep them in check. Pyrethrum, kerosene, etc., may be used direct upon the fowls, and if they are liberally supplied with ashes and road dust they will do much to protect themselves.

Menopon biseriatum Piaget;=*M. stramineum* Nitzsch.

Under the above name Piaget describes a species of louse taken from the *Gallophasis cuvieri*, and which he speaks of as occurring also on the domestic fowl, the pheasant, and other birds. He says:

> Sur un *Gallophasis* (*Euplocamus*) *cuvieri* j'ai retrouvé le même parasite sur un *Gallus domesticus*, sur un *Phasianus colchicus*, sur un *Pavo spiciferus* male et femelle en assez grand nombre et dernièrement aussi sur une *Meleagris gallopavo*. Il se rapproche évidemment du *stramineum* de N., promenent d'une *Meleagris gallopavo*, dommage que la diagnose de Giebel (Epiz., p. 291) soit trop vague pour l'identifier, mais plus encore du *Pediculus meleagridis* de Panzer (51, f. 20). Peut-être est-ce le parasite de Schrank No. 1019, recueilli sur le même oiseau.

It seems very probable that the description of Panzer, Nitzsch, Giebel, and Piaget all apply to the same insect, and if such is the case it would carry the recognition of the species back to 1793, when it was described by Panzer under the name of *Pediculus meleagridis*.

It would seem to be confined more particularly to the Phasianidæ, and of these to infest particularly the peafowls and turkey, though its occurrence on the hen is frequent. It would evidently pass readily from any of these birds to others in the same family. From specimens received it would seem to be rather common on chickens in the United States.

THE PHEASANT MENOPON.

(*Menopon fulvo-maculatum* Denny; *M. productum* Piaget.)

Denny, in his monograph published in 1842, describes and figures, under the name of *Menopon fulvo-maculatum*, a species of louse occurring on the quail and pheasant. Piaget describes also a species occurring on pheasants (*Phasianus pictus* and *P. colchicus*), which he considers as probably the same as Denny's, though neither the description nor the figure enable him to determine certainly.

According to Denny, "it is fulvous yellow and pubescent; head semilunar, with a pitchy transverse spot on each side; abdomen clavate, with pale spots on the lateral margin."

Piaget says it is very similar to *M. pallidum*, though distinct, and calls the color, "jaune ocre, fauve sur les cotés de l'abdomen."

Piaget also describes a variety (*major*) taken from the *Lophopharus resplendens*.

THE PEACOCK LOUSE.

(*Menopon phæstomum* Nitzsch.)

This species is apparently confined to the peafowls, as since its description in 1818 it has been taken only from these birds. Piaget states that it occurs on three different species, *Pavo spiciferus*, *P. cristatus*, and *P. javanicus*. It has not been recorded from this country, but is likely to be found by searching these birds.

Louse of the Guinea Hen.

(*Menopon numidæ* G.)

Giebel seems to have been the first to have mentioned this species, and we may infer that it is usually not abundant. Piaget speaks of it as similar to the *Menopon phæstomum* N.

We have not had opportunity to make careful search for it, but it doubtless occurs on guinea fowls in this country. It would probably be difficult for an ordinary observer to distinguish between this and the common species infesting hens, and even if noticed in abundance on guinea fowls it would very likely escape mention.

Louse of Ducks.

(*Trinoton luridum* Nitzsch.)

Redi seems to have been the first to give mention of this very common species, it being figured in the Exper., Pl. XII, as the louse of the teal. It is also figured by Albin (pl. 46) under the same common name as quoted by Denny. Nitzsch described it in 1818 under the name given above, and the species has been fortunate enough not to have received any other designation since, although it has been mentioned in most of the works referring to the parasites of domestic fowls or the parasites of birds. It is a very common species and occurs on a great many different species of ducks, so that it is unnecessary to try to enumerate the hosts. So far as we have seen or can learn from record, however, it is not known to occur on birds outside of the duck family (*Anatidæ*).

Its nearest ally is the goose louse, to be mentioned next, and it is easily distinguished from that by the difference in size and the more distinct markings in this species. The markings are shown in the accompanying figure, their distribution on the head, thorax, and abdomen being clearly indicated. The abdomen in the specimen figure is a trifle narrower and the sides a little more parallel than in some specimens observed. It is 4 to 5 mm. in length.

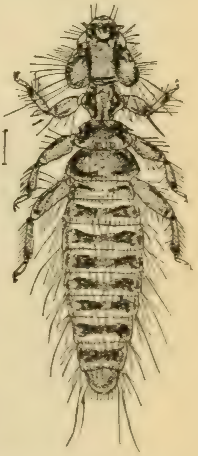


FIG. 137.—*Trinoton luridum*—enlarged (author's illustration).

Louse of the Goose and Swan.

(*Trinoton conspurcatum* Nitzsch.)

This species was evidently recognized at an early date, and is said to be mentioned by Sulzer under the name of *Pediculus anseris*. Nitzsch described it in 1818 under the name which has been universally adopted since, and it has received frequent mention since that time. It is very similar to the *Trinoton luridum*, but may generally be easily separated by the more diffuse coloring and its larger size, being 6 mm. (3 lines according to Denny) in length. The two species are not known to infest the same kinds of birds. This louse occurs on a number of species of geese and swans, and on one gull; according to Denny, on the common domestic goose, on the *Larus canus*, and *Cygnus bewickii;* on *Cygnus olor*, according to Burmeister; on *C. musicus* and *olor*, according to Piaget; and on *Anser ruficollis*, according to Grube.

While the *Trinoton luridum* we have found to be rather common in America, the *conspurcatum* has not been met with, but the opportunities for examining geese have been limited.

Louse of the Goose.

(*Trinoton lituratum* Nitzsch.)

This quite distinct species of louse has been known to entomologists since 1818, when it was described by Nitzsch. Denny, however, did not recognize the application of the description to this form and redescribed it under the name of *Trinoton squalidum*. Later writers, however, have adopted the earlier name, and there will probably be no further confusion regarding it.

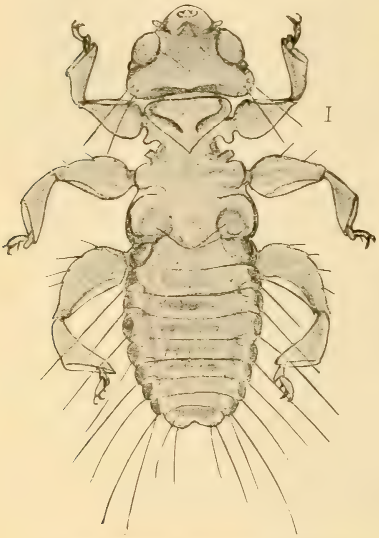


Fig. 138.—*Trinoton lituratum*—enlarged (author's illustration).

It is quite easily distinguished from the other species of Trinoton, being considerably shorter, smaller, and of a nearly white color.

It occurs, according to Denny, on *Anser albifrons*, the domestic goose, and on *Anas clypeata*. It is also referred to the Smew, and Piaget states that it has been taken from *Dendrocygna arborea* and *Anser albifrons*.

The Pigeon Louse.

(*Colpocephalum longicaudum* Nitzsch.)

Nitzsch described this form, which occurs on pigeons, in 1818, but it was again described by Denny in 1842, who gave it the name of *turbinatum*. Giebel retained both these names, evidently considering that they referred to distinct species, but Piaget has placed them together.

The species would not seem to be so abundant as some of the other species of pigeon lice, and it has not been found as yet on pigeons that we have had an opportunity to examine.

It does not appear to have been found on any other birds, but has been taken from the common domestic pigeon and also the turbot.

THE SWAN LOUSE.

(*Colpocephalum minutum* Rudow.)

Rudow seems to have been the first to recognize this species, though its occurrence upon the swan (*Cygnus musicus*) makes it rather strange that it should have escaped observation so long. It is a very small species, as would be inferred from the name, and this may account in part for its not having been earlier noticed.

It has not been recorded from this country, but may be looked for upon our species of swans, as the lice infesting these birds are generally widely distributed.

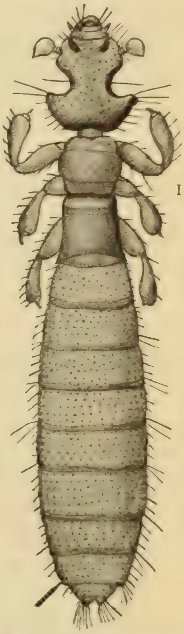


FIG. 139. — *Gyropus gracilis*—enlarged (after Denny).

LOUSE OF THE GUINEA PIG.

(*Gyropus gracilis* Nitzsch.)

The guinea pig is perhaps a rather unimportant factor among the domesticated animals, but it supports its due quota of parasites nevertheless, and they require a brief mention, at least. They are quite interesting in structure, differing largely from any of the species considered hitherto.

The one to first receive notice, and probably the one here given, was referred to by Schrank under the name of *Pediculus porcelli*, but Nitzsch, in 1818, described it as *Gyropus gracilis*, a name which has been used by all subsequent writers.

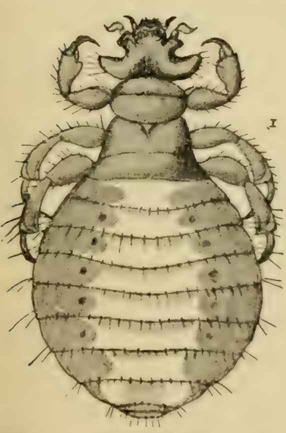


FIG. 140.—*Gyropus ovalis* — enlarged (after Denny).

It is referred to generally by writers on the subject, and would seem to be a fairly common species where guinea pigs are kept. It has not been met with in this country so far as records show, but may be looked for with great probability of success in any place where guinea pigs are kept in numbers.

Denny characterizes it as "elongate, pale, fulvous-yellow, finely pubescent; head and thorax darker, segments of the abdomen with transverse striated fascia at the sutures; tarsi and ungues very short and minute." Collected at Baltimore by Dr. A. Hassall.

Gyropus ovalis Nitzsch.

This is a form closely related to the preceding species, and observed and described by Nitzsch at the same time. It differs from that species in the much shorter and broader body, and is, according to Denny, "pale yellow-white; head and thorax bright ferruginous, the former transverse; temporal lobes produced; abdomen large, nearly orbicular; legs thick, the two posterior pairs curved; ungues long, curved, and strong." Collected at Baltimore by Dr. A. Hassall.

The scanty hair of the guinea pig makes the application of washes for the destruction of the lice a very simple matter, so that wherever it is a matter of importance there need be no difficulty in ridding the animals of the parasites.

APPENDIX TO MALLOPHAGA.

List of the species of Mallophaga recognized as belonging to the fauna of the United States, with descriptions of new species.

Family PHILOPTERIDÆ.

Docophorus platystomus N.

Burmeister, Handbuch, Vol. II, p. 426, sp. 13; Denny, p. 108, Pl. IV, fig. 7; Giebel, Epiz., p. 69, Taf. IX, fig. 5; Piaget, p. 17, Pl. I, Fig. I.

From sharp-shinned hawk (*Accipiter velox*), Rhode Island (H. C. Bumpus), *Buteo swainsonii*, Iowa (?) (H. O. collection.). *Aquila imperialis* (Burnett collection).

Docophorus cursor N.

Burmeister, Handbuch, Vol. II, p. 426, sp. 14; Denny, p. 101, Pl. II, Fig. I; Giebel, p. 75, Taf. X, figs. 5 and 6; Piaget, p. 24, Pl. I, fig. 5.

From *Asio wilsonianus*, Ames, Iowa. Lincoln, Nebr. (Bruner).

Docophorus ceblebrachys N.

Denny, p. 92, Pl. I, fig. 3; Nitzsch MSS., Vol. IV, p. 197 (cited by Denny), and Zeits. für Natur., 1861, Vol. XVII, 528; Giebel, p. 77, Taf. XI, fig. 15; Piaget, p. 29, Pl. I, fig. 8.

From snowy owl, Iowa (H. O. collection; Cassino collection), Arctic Am. (Stejneger collection and McKay collection). Also specimens in Nat. Mus., Acc. No. 16827, and in Riley collection. It occurs very abundantly on this bird, but so far there is no record of its occurrence on any other species.

Docophorus superciliosus N.

Burmeister, Handbuch, Vol. II, p. 427, sp. 22; Denny, p. 69, Pl. III, fig. 9; Giebel, p. 94, Taf. X, fig. 3; Piaget, p. 39, Pl. III, fig. 1.

From hairy woodpecker (*Dryobates villosus*) (Cassino collection).

Docophorus communis N.

Nitzsch, Germar's Mag., Vol. III, p. 920 (290) (vide Giebel); Burmeister, Handbuch, Vol. II, p. 425, sp. 9; Denny, p. 70, Pl. V, fig. 10; Giebel, p. 85, Taf. XI, fig. 13; Piaget, p. 54, Pl. IV, fig. 5.

From *Lanius borealis*, Ames, Iowa. Shore lark Cassino collection).

Docophorus compar Piaget.

Piaget, p. 61, Pl. VII, fig. 1.

From *Loxia c.-minor*, Ames, Iowa.

Docophorus bassanæ Denny.

Monog. Anop. Brit., p. 110, Pl. VI, fig. 3, Pl. VII, fig. 3.

Host unknown, probably the gannett (Burnett collection).

Docophorus fissiformis Denny.

Monog. Anop. Brit., p. 84, Pl. I, fig. 2.

On "black-billed sandpiper" (Burnett collection).

Docophorus testudinarius Denny. (Fig. 1, Pl. II.)

Denny, p. 96, Pl. I, fig. 6; Piaget, p. 83, Pl. VI, fig. 5.

From curlew "*Numenius longirostris*," Ames, Iowa. Specimens from this bird agree so closely with the figures and descriptions of the above species occurring on the related *Numenius arquatus* of Europe that I see no occasion to give it a separate description. On *Bartramia longicauda*. (Burnett collection.)

Docophorus bisignatus N.

Insecta Epiz., p. 106, Pl. IX, fig. 9; Piaget, Les Pédic., p. 92.

On *Ibis alba;* collection of C. B. Cook.

Docophorus sphenophorus Nitzsch.

D. phataleæ Denny, p. 100, Pl. IV, fig. 9.

A specimen of this well-marked species in the Cassino collection is without indication of host or locality, but it is doubtless American, probably from spoonbill.

Docophorus pertusus Nitzsch.

Recorded by Kellogg, from coot (*Fulica americana*) at Monterey, Cal., and Lawrence, Kans.; also from ruddy duck (*Erismatura rubida*) at Monterey, Cal.

Docophorus lari Fabr.

Pediculus lari Otto Fabricius, Fauna Groenlandica, p. 219.

Docophorus lari Denny, p. 89, Pl. V, fig. 9; Piaget. Les Pédic., p. 111, Pl. IX, fig. 7.

From herring gull (Cassino collection) and *Larus philadelphia* (Burnett collection). Also recorded by Kellogg from several species of gulls in California.

Docophorus colymbinus Denny.

Monog. Anop. Brit., p. 80, Pl. VIII, fig. 8.

On *Urinator lumme* (Burnett collection).

Docophorus icterodes Nitzsch.

Nitzsch, Germar's Mag., Vol. III, p. 290; Denny, p. 102, Pl. V, Fig. 11; Giebel, Vol. III, pl. 10, fig. 8; Piaget, p. 114, Pl. X, Fig. 1; Osborn, Bull. 7, Div. Ent., U. S. Dept. Agr., p. 31.

A very common species on many kinds of ducks. Specimens have been noted in the Cassino, Burnett, and Stejneger collections, and also taken at Ames, Iowa. The Burnett specimen shows the clypeus more quadrate than in other specimens, especially many specimens taken at Ames in which the clypeus is quite decidedly rounded at lateral margin. Recorded also by Kellogg.

Docophorus cygni Denny.

Denny, Monog. Anop. Brit., p. 95; Giebel, Epiz.; Piaget, Les Pédic., p. 115, fig. 3, Pl. X.

From swan (*Olor buccinator* (?)), Ames, Iowa. Very abundant.

Docophorus rostratus Nitzsch.

Docophorus rostratus; Burmeister, Handbuch, Vol. II, p. 427; Denny, p. 87, Pl. II, fig. 4; Giebel, p. 76, Pl. X, fig. 4; Piaget, p. 27, Pl. I, fig. 7.

A specimen of this well-marked species from the barn owl (*Strix pratincola*) in the collection of Prof. Lawrence Bruner. There is no difference of note between this and the European form as described, though it is perhaps a little more slender and elongate than the figures would indicate. Even this is possibly due to extension of abdomen from pressure of cover glass in mounting.

Docophorus melanocephalus Burm.

In Burnett collection. Great Cayenne tern. Recorded by Kellogg, New Mallophaga, p. 99, on royal tern (*Sterna maxima*), Monterey, Cal.

Docophorus buteonis Pack.

Packard, Am. Naturalist. Vol. IV, p. 93, Pl. I, fig. 3.

Packard's description of this species seems not to have been accessible to Piaget, or he was unable to verify it, as he passes it with a mere mention. (Les Pédic., p. 22.)

I have specimens from *Buteo lineatus*, the hawk from which Packard described the species, sent me by Dr. C. M. Weed, of Hanover, N. H., which agree entirely with Packard's description, and they appear to me to be sufficiently distinct from other species to be retained. Packard's description is as follows:

> The species of Docophorus figured on Pl. I, fig. 3, appears to be undescribed, and may be called *D. buteonis.* It lives beneath the feathers of the red-shouldered hawk. It is honey yellow, and the abdomen is whitish with triangular chitinous plates on each segment, the two on the segment next to the last forming a continuous band. The head is longer than broad, with the trabeculæ (or movable horny process just in front of the antennæ) as long as the two basal joints of the antennæ, and extending to the middle of the second joint. The basal joint of the antennæ is rather thick, and the second joint is as long as the two terminal ones.

Both description and figure are wanting in reference to characters which would most certainly distinguish the species, and I may add that the species is separated from *platystomus* by the deeper incision of the clypeus, and the more circular outline of the clear lateral dilation. The genital patches are approximate and the proximal margins of the patches denticulated; the outer portion of the patches faint.

A specimen in the Burnett collection from *Tyrannus atra* is referred here.

Docophorus halieti n. sp.

Head a little wider than long, clypeus tapering but with dilated apical portion emarginate in front. The transparent dilation but little in advance of antennal bands, but curving outward so as to show as a clear part at sides; emargination shallow and reaching inner portion. Trabeculæ simple, bluntly pointed, antennæ slender, eye prominent, clypeus and temporal borders with few short hairs, abdomen ovate in female, round in male, sparsely hairy above and below, thickest on disk above; all hairs rather short. Genital hooks, male sharply curved, between them several prominent teeth. Genital spot male, large, distinct, the anterior lateral oval portion wide apart connected to central portion by inflated band; central portion broad, widening at middle incised by lateral border behind, the wider part with two hair insertions on posterior half, extending to tip of last segment. Genital spot female, curved, the inner convex margin approximate, the outer concave portion inclosing near the front an oval spot. Approaches *intermedius* Piaget, which is described from *Haliœtus vocifer*. It differs from that species in having the clypeus more emarginate for the transparent portion, the dense portion narrower at tip. The genital hooks are decidedly hooked, the genital patch of male heavier and the posterior portion broader. The genital spots of female approach closely to pattern of *platystomus*.

From bald eagle (*Haliœtus leucocephalus*) collected by Dr. C. M. Weed, in Florida.

Docophorus bubonis n. sp.

General appearance of *D. ceblebrachys*, from which it differs distinctly in form of head and genital hooks, and in eyes being very obscure. Head oval, narrowing from eyes to occiput, broadest at base of trabeculæ, contracting sharply to front; eyes very obscure or wanting, scarcely any convexity indicating their position, and no trace of pigment beneath. Occiput slightly curved, temporal lobes narrow, long, contracted posteriorly; median space between occipital bands narrow behind; antennæ situated slightly in front of middle. Trabeculæ small and rigid, as in *ceblebrachys*. A very short hair at each side of transparent portion of front, a longer hair at middle of external clypeus band, and two hairs on margin of temporal lobe. Prothorax short, metathorax broader than basal segment of abdomen. Abdomen widest behind middle at fourth and fifth segment. Light yellow bands, extending more than half way to middle disk, hairy, seventh segment with dorsal margin. Male genital hooks prominent, long, heavy, sharply curved at top.

Two specimens, male and female, in Cassino collection, from *Bubo virginianus*, Pennsylvania. This is a well-marked species, although showing decided affinities to *ceblebrachys*. The form of head in narrowness and length behind the antennæ will distinguish it from almost any described species, the reduction of the eyes is very marked, and the form of the genital hooks give it well-established characters. In form of head and rigidity of trabeculæ it approaches Nirmus, but the character of the clypeus and the general form of body, as well as its evident relationship to *ceblebrachys*, would prevent its reference to that genus.

Docophorus syrini Packard—cited in Piaget, p. 31—Gurlt.

I have not met with this description, nor with any form which would seem to represent it.

Docophorus quiscali n. sp.

Clypeus broad, lateral angles rounded, with front slightly incurved, in some cases almost truncate, nearly as broad at tip as at base of trabeculæ, transparent for about one-fourth distance from tip to trabeculæ. Trabeculæ large, curved, and with rather acute tip; margin of clypeus and head with scattering hairs; metathorax with a complete band posteriorly set with hairs; abdominal segments with bands extending about one-third across the posterior border of these bands, with clear spots from which arise long, rather slender hairs. The eighth segment with the brown band extended entirely across. Beneath a large brown patch occupying the

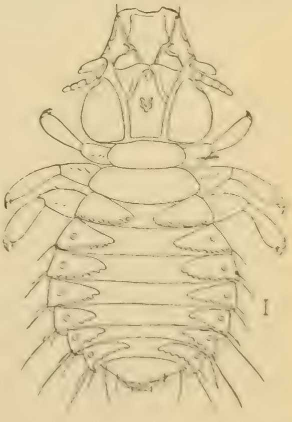


FIG. 141.—*Docophorus quiscali*—enlarged (original).

sixth, seventh, and touching the eighth segment, regularly rounded in front, roughly excised behind; brown spots located near the margin on each segment back to the eighth; those on the sixth segment form the outer portion of the genital patch. Length, 2 mm.

General appearance of *communis*, of which it might be considered a variety, but it is quite distinct and constant in form of clypeus and genital patch, and seems to occur only on Quiscalus, its nearest ally being a species occurring on *Agelaius phœniceus.*

From crow blackbird, collected at Ames, Iowa.

This is a very common species on this host, and I have noted it in various collections.

Docophorus agelaii n. sp.

Similar to *quiscali*, but slightly narrower. The clypeus truncate or slightly rounded, the sides sloping; trabeculæ curved on front margin, straight behind; the apex somewhat acuminate; bands on the abdomen broad, much incised at insertions of the hairs; band on the eighth segment contracting in the middle, almost broken. Beneath, the genital patch large, strongly curved in front, deeply and irregularly incised behind; lateral spots small, rather elongated, oblique. Quite close to *quiscali*, and both might be considered varieties of *communis*, but seem well established.

Docophorus sialii n. sp.

Clypeus tapering, lateral angles rounded, front convex, or very slightly incurved at extreme apex; no transparent portion in front of the chitinous bars; trabeculæ strongly curved in front, slightly curved behind, acuminate at tip.

On *Sialia sialis*, Merriam Coll. Belongs to *communis* group, but separated by head characters.

Docophorus corvi n. sp.

Whitish, with black and fuscous bands and stripes.

Length of body, 2.5 mm.; head, 0.75 mm.; abdomen, 1.17 mm. Width of head, 0.70 mm.; abdomen, 0.98 mm.

Head scarcely longer than wide, truncate in front; clypeus broad; clypeal signature acuminate and elongate posteriorly; posterior part black; anterior portion with a broad fuscous margin; antennal bands deep fuscous; trabeculæ strong, convex in front, slightly concave behind, blackish band at base extending along posterior border; antennæ rather slender, basal joint largest, with a black band extending nearly around, deepest in front; second joint slender, long, mostly black, with a deep incision of the black portion toward the tip, joints 3, 4, and 5 nearly equal, black, distal joint scarcely as dark as the others; eyes prominent; temporal lobes clear, with black border, in which are three clear spaces, from which hairs arise; occipital bands very black; occiput slightly sinuous. Prothorax narrow, with broad, black margin; metathorax nearly twice as wide as prothorax, lateral angles rounded, deeply margined, with black extending medially and nearly uniting; each side set with about eight hairs arising from round, clear pustules. Legs banded and striped with black; abdomen oval, with broad fuscous marginal bands extending well upon the disk; the posterior margin set with hairs which arise from circular pustules near the margin and from notches in the band on the disk; large, clear, circular spots marking position of spiracles; eighth segment with a broad band extending clear across; ninth segment with two triangular patches approximate anteriorly; lateral angles with

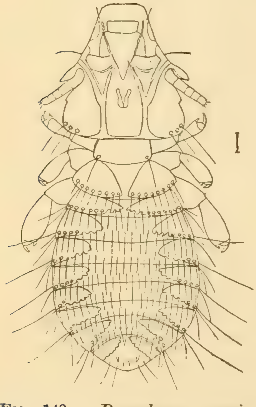


FIG. 142. — *Docophorus corvi* — enlarged (original).

two or three long, slender hairs; gula with a fuscous patch produced in front; sternum with a small fuscous patch pointed anteriorly; genital bands rounded in front, with two circular, clear spots behind the front border extending to near the margin on the sixth segment, posteriorly produced; a rather narrow, rough-edged process on the seventh segment; a series of submarginal spots on segments 3 to 9, those on the eighth and ninth merging into a single triradiate spot.

Common on *Corvus americanus*, Ames, Iowa. This is probably Packard's *Lipeurus corvi*, which was evidently described from an immature specimen.

Docophorus minuto-trabeculatus n. sp.

Head pointed, strongly tapering before antennæ; clypeus narrow, slightly convex in front; anterior portion transparent; clypeal mark rounded behind, no hairs; trabeculæ very small, giving appearance of a Nirmus to side of head; eye not prominent; antennæ short, rather strong, joints equal, two hairs on margin; temporal lobes full; occipital bands not conspicuous; all bands on head joint, occiput straight; prothorax about half the width of head, colored at sides, central stripe light; metathorax curved behind, colored at sides, central stripes continuous, with prothorax clear; colored portion incised for insertions of hairs of posterior border; lateral bands of abdomen very short, except on first segment, where they extend inward as far as colored portion of thorax, bands less prominent on posterior segments; eighth without coloration; two faint spots on terminal; ninth segment, abdomen, oval, nearly round; a row of four hairs each on segments 3, 4, 5, and 6, marginal hairs on each segment back of fifth; legs colored yellow; tibiæ larger than femora; color light yellow for colored portions, mostly whitish, possibly not fully mature, but has appearance of adult.

On *Fulica americana.*

Differs in form of clypeus and abdomen from any species known to me as occurring on related birds. Collected from a stuffed bird in the museum of the Iowa Agricultural College. In the minuteness of the trabeculæ this species might be taken for a Nirmus, but in the form of the head and abdomen, and in general appearance it is decidedly a Docophorus.

Docophorus fusco-ventralis n. sp.

Quite uniformly chestnut brown, rather slender.

Length, 1.26 mm.; head, 0.47 mm.; abdomen, 0.61 mm. Width of head, 0.40 mm.; abdomen, 0.47 mm.

Head longer than wide; clypeus, broad, truncate, thin in front, and with a ventral notch at tip; clypeal signature strong, a long, strong, dark-brown spine passing backward to a point midway between antennæ; sides of clypeus a little concave; trabeculæ strong, forward margin curved (shape of *communis*); antennæ slender, light brown; temporal lobes rounded; occipital bands running outward to bases of antennæ; occiput nearly straight; prothorax small, sides straight, widening a little behind, posterior border slightly convex; metathorax broader, widening rapidly, distinctly angled behind, hind border with a row of hairs; abdomen above brown, lateral bands reaching nearly to center, leaving a narrow, whitish, membranous stripe from base to eighth segment; eighth segment entirely corneus and brown, margin with blackish line, a row of strong, golden hairs on posterior border of each segment to eighth; beneath uniformly dark brown, obliterating genital bands; legs small, quite uniform with body in color.

On wood pewee (*Contopus virens*) Cornell University collection; also in the Burnett collection.

Approaches *communis* type in some respects, but differs, I think, from any variety of *communis* in approximation of bands on abdomen and uniform brown color of ventral surface of abdomen and size of legs.

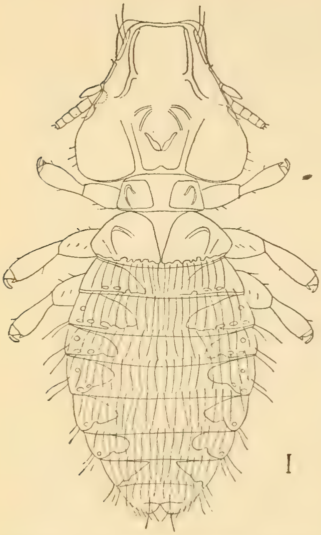


FIG. 143.—*Docophorus coccygi*—enlarged (original).

Docophorus coccygi n. sp.

Head large, in male nearly as large as abdomen, bright ferruginous; abdomen whitish, except in center and corneous portions, which are dark, almost blackish, and give abdomen a bluish-black cast.

Length, 2.5 mm.

Head large, triangular; clypeus broad, emarginate in front between produced chitinous rods and with transparent expansion laterally, bearing three long hairs each side, a depressed excavation above, but with signature inconspicuous; trabeculæ rather small, bluntly curved toward apex in front, point acutely angled; antennæ slender; eyes not conspicuous; temporal lobes regularly rounded; hind border of head nearly straight, very slightly concave; prothorax quadrate, slightly widening behind; metathorax widened behind, posterior border regularly curved. A transverse band behind the middle faint in front, distinct behind, and with its hind border incised by circular spots, from which originate a series of hairs.

Abdomen short, broad, scarcely wider than head, mostly covered with dark fasciæ, but the membranous portions whitish. Female beneath, with brown fasciæ or circular spots forming a series around border, a pair on sixth segment extending farthest into disk, and on eighth segment nearly meeting on median line with denticulated border. Male with a broad median ventral stripe running from disk to margin of terminal segment, and with broad lateral fascia on the discal segments.

On yellow-billed cuckoo, Lincoln, Nebr., collected by Lawrence Bruner. Differs from *D. latifrons* in having narrowed clypeus and in markings of ventral surface of abdomen.

Docophorus speotyti n. sp.

Head longer than broad, or in female almost as wide as long, tapering with a little concavity to front, margin of clypeus in front truncate or slightly convex of medium width; signature long, acute, but not deeply colored; trabeculæ short, acutely pointed, very slightly swollen at base; antennæ slender, joints 1 and 2 equal, each nearly twice as long as 3, 4, or 5, the latter equal in length; temporal lobes narrow.

Body rather slender; prothorax quadrate; meso-metathorax wider than basal segment of abdomen. Abdomen narrow in male, almost parallel; in female widening to fifth segment, clothed with long hairs and with dorsal fasciæ, rather short in female, longer in male; color, light brown.

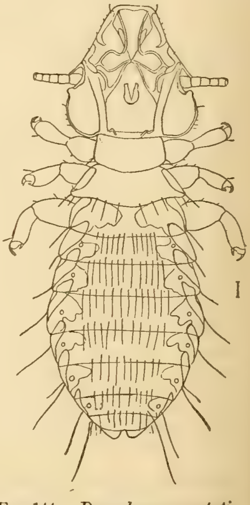


FIG. 144.—*Docophorus speotyti*—enlarged (original).

Length, male, 1.70 mm.; female, 2 mm.

On burrowing owl (*Speotyto cunicularia hypogæa*); from Prof. Lawrence Bruner, Lincoln, Nebr., 1 male, 1 female, and from C. F. Baker, Fort Collins, Colo., 2 males, 2 females.

Docophorus calvus Kellogg.
New Mallophaga, p. 79, Pl. III, fig. 1.

On *Uria troile californica*, Monterey, Cal. (Kellogg).

Docophorus fuliginosus Kellogg.
New Mallophaga, p. 80, Pl. III, fig. 2.

On *Charadrius squatarola*, Lawrence, Kans. (Kellogg).

Docophorus graviceps Kellogg.
New Mallophaga, p. 82, Pl. III, fig. 3.

On *Fulica americana*, Monterey, Cal. (Kellogg).

Docophorus acutipectus Kellogg.
New Mallophaga, p. 84, Pl. III, fig 4.

On *Cerorhinca monocerata*, Monterey, Cal. (Kellogg).

Docophorus quadraticeps Kellogg.
New Mallophaga, p. 85, Pl. III, fig. 5.

On *Fulica americana*, Monterey, Cal. (Kellogg).

Docophorus montereyi Kellogg.
New Mallophaga, p. 87, Pl. III, fig. 6.

On *Synthliborhamphus antiquus*, *Brachyrhamphus marmoratus*, and *Ptychorhamphus aleuticus*, Monterey, Cal. (Kellogg).

Docophorus occidentalis Kellogg.
New Mallophaga, p. 89, Pl. III, fig. 7.

On fulmars, *Fulmarus*, Monterey, Cal. (Kellogg).

Docophorus kansensis Kellogg.
New Mallophaga, p. 91, Pl. III, fig. 8.

On eared grebe, *Colymbus nigricollis californicus*, Lawrence, Kans. (Kellogg).

Docophorus atricolor Kellogg.
New Mallophaga, p. 93, Pl. III, fig. 9.

On murrelets, Monterey, Cal. (Kellogg).

Docophorus insolitus Kellogg.
New Mallophaga, p. 94, Pl. IV, fig. 5.

On Aleutian murrelet, *Ptychoramphus aleuticus*, Monterey, Cal (Kellogg).

Nirmus discocephalus N.

On *Haliætus leucocephalus* (Burnett collection).

Nirmus euzonius Nitzsch.

On *Gypaëtus barbatus* (Burnett collection).

Nirmus fuscus Nitzsch.
Nirmus fuscus Nitzsch MSS., Denny, p. 118, Pl. IX, fig. 8; Giebel, p. 123, Pl. VIII, fig. 2.

From *Buteo swainsoni*, Ames, Iowa, *Accipiter velox* (Merriam).

Nirmus brachythorax Giebel.
Giebel, p. 134; Piaget, p. 150, Pl. XII, fig. 8.

From *Ampelis cedrorum*, Ames, Iowa.

Nirmus submarginellus N.
Nitzsch, Zeitschr. für g. Naturwissensch., 1866, Vol. XXVIII, p. 368; Giebel, p. 148; Piaget, p. 155.
Nirmus menura-lyræ, Coinde, Bulletin de Moscou, Vol. IV, p. 424.

From lyre-bird, *Menura superba*, (Museum specimen ?) Mich. (C. B. Cook collection).

Nirmus fenestratus N.

On *Coccyzus erythrophthalmus* (Burnett collection).

Nirmus cyclothorax Nitzsch.

Burmeister, Handbuch, Vol. II, p. 429, fig. 10; Denny, p. 150, Pl. XI, fig. 6; Giebel, p. 137, Pl. VI, fig. 9; Piaget, p. 162.

From English sparrow, *Passer domesticus* (Laurent collection), and *Acanthis linaria* (?) (C. B. Cook collection).

Nirmus candidus Nitzsch.

On *Melanerpes carolinus* (Burnett collection).

Nirmus ornatissimus Giebel.

Giebel, p. 144; Piaget, p. 163.

From *Agelaius phœniceus* (Cassino collection).

This handsome species can quite certainly be referred to Giebel's species, though his description is not very full.

Nirmus ornatissimus, var. **xanthocephali**, n. var.

In the male the ventral median patch is extended to the tip from the sixth segment, there being clear lateral spaces on segment 6, and a large, clear median space on segments 7 and 8, and lines of dusky running from this patch to margin of segments posteriorly on 6 and 7 and a small spot on 8 at sides.

On yellow-headed blackbird (*Xanthocephalus xanthocephalus*), collected at Fairfax, Iowa (H. O. collection).

Nirmus pileus, N.

Nitzsch, Germar's Mag., Vol. III, p. 291; Zeitschr. für g. Naturwissensch., 1866, Vol. XXVIII, p. 373; Giebel, p. 162; Piaget, p. 182, Pl. XV, fig. 6.

From stuffed specimens of avocet, in museum of Iowa Agricultural College. A well-marked species, our specimen agreeing perfectly with description in European works.

Nirmus citrinus Nitzsch.

Nirmus citrinus Nitzsch, Zeitsch. für gesammt. Naturwissensch., 1886, Vol. XXVIII, p. 378.
Nirmus alcœ Denny, p. 137, Pl. IX, Fig. I.
Nirmus citrinus Giebel, p. 177; Piaget, p. 190, Pl. XVI, fig. 8.

From *Alleus alle* (Cassino collection), *Simorhynchus pygmæus*, *S. cristatellus*, *S. pusillus*, and *Synthliborhamphus* (Stejneger collection).

Nirmus lineolatus Nitzsch.

(1839) *Nirmus lineolatus* Nitzsch. Burmeister, Handbuch, Vol. II, p. 428. (No description.)
(1851) *Nirmus ornatus* Grube, v. Middendorff's Sibir. Reise 477, Taf. 1, fig. 4 (vide Giebel).
(1866) *Nirmus lineolatus* Nitzsch. Zeits. für ges. Naturwis., Vol. XXVIII, p. 376; Giebel, 177, Vol. IV, pp. 5, 6, 7, 8; Piaget, 199, Pl. XVI, fig. 3.

From herring gull, in collection of S. E. Cassino; Baker collection, Elkhart, Ind.; also recorded by Kellogg, New Mallophaga. So far as I can discover, there is no description of this species prior to that of Grube's in 1851, the name alone appearing in Burmeister.

Nirmus signatus Piaget.

Les Pédic., p. 186, Pl. XV, fig. 8.

From avocet, collected from stuffed bird in museum of Iowa Agricultural College.

This species has so much the aspect of a Lipeurus that I fail to see on what basis Piaget places it in Nirmus. It is readily characterized by the prolonged point to clypeal signature.

Nirmus gracilis N.

Nirmus gracilis Nitzsch.
Nirmus elongatus Denny, p. 140, Pl, VII, fig. 4.
Nirmus gracilis Piaget, p. 157, Pl. XIII, fig. 10.

Small, light brown.

The head and body both lanceolate in shape. Head abruptly lanceolate, the tip narrow and forcipated; clypeal suture fairly distinct, a transparent anterior border projecting slightly in front of the forceps like side pieces and involute, furrowed beneath, and a narrow slit passing backward from this furrow to the mandibles; trabeculæ inconspicuous; antennæ short, first joint but little larger than the others; temporal lobes curved on the lateral margin; posterior angles abruptly rounded with a single hair; occipital very slightly concave; prothorax constricted behind; metathorax much wider behind than the base of abdomen, with a fringe of long hairs; abdominal segments about equal in length, light brown, with a central lighter stripe and sutural margins and a lighter submarginal space, giving a series of four quadrate round margins to each segment; posterior margins of the segments without hairs except a single one at the lateral angles of segments 2 to 5, two on segments 6 to 7, and several scattering hairs on terminal segment.

Described from one specimen taken from the purple martin (*Progne subis*), Ames, Iowa, in company with numerous specimens of Menopon and Docophorus.

The lanceolate form of the head and the body and narrow forcipated tip of the clypeus are the most distinctive characters of the species.

While evidently to be referred to the above species, the description will indicate the details of character in our form.

Nirmus furvus Nitzsch.

Nirmus furvus Nitzsch.
Nirmus obscuris Denny, p. 147, Pl. X, f. 6.
Nirmus furvus Giebel, p. 163, Pl. V, f. 2, 3.
Nirmus obscurus Giebel, p. 16.
Nirmus furvus Piaget, Les Pédic., p. 169, Pl. XIV, f. 3.

Brown, with a distinct dark border. Head elongate; clypeus tapering, with a distinct suture, circular in front and with a wide clear margin, a short hair on each side; antennal band heavy, internal band narrower, approaching the antennal band in front of trabeculæ, a median light line reaching the mandibles from the clypeal suture; trabeculæ sharp, conic, transparent; antennæ with second joint as long as the third and fourth; temporal lobes slightly widening behind, posterior angles regularly curved; occiput slightly incurved; prothorax margined with dark brown, widening behind; metathorax twice as long as prothorax, broadly margined with brown, widening to behind the middle, where there appears to be a pretty distinct suture, as if the mesothorax and metathorax were not fused, with two prominent hairs on each lateral angle; legs brown; femora thick, paler on under side; abdomen with a broad, dark-brown or blackish margin, light brown in the disk, with a light line on each segment from 2 to 6; the posterior end of this line merging into a dark circular spot open in front; segments 1 and 2 with two hairs each arising from clear dots each side of the central dark spot; segments 3, 4, 5, and 6 with hairs arising from light dots on posterior margin, two bordering the black central spot, the others midway from these spots to the margin; seventh segment with hairs near the posterior angle; eighth with two lateral hairs each side; segments 2 to 7 with short hairs on the outer angle.

Described from one female specimen, taken from *Phalaropus tricolor*, in the museum of the Iowa Agricultural College.

The species is specially marked by the presence of the central line on the abdominal segments 2 to 6, which, merging into the dark spots, resemble a series of locks. The general agreement with descriptions of *furvus* is very close and it is referred to this species.

Nirmus rotundatus n. sp.

Very broad and conspicuously marked with black and dark brown; type of *latifasciati*. Head cordate, regularly curved in front, very slightly conic, the tip barely truncate, the antennæ and internal bands broad and prominent and inclosing a broad lateral clear space; also a broad, clear furrow from tip to mandibles, broadening in front of mandibles to form a wide, clear arc; trabeculæ inconspicuous, antennæ short, first two joints thicker than others, all but first annulate with black, last three nearly equal; occiput slightly incurved, a long hair at posterior angle of temporal lobe; prothorax widening behind, dusky at sides; metathorax widening much behind, a blackish band running across a little behind the center of posterior margin, obtusely angled, set with bristles; legs large, femora at base above and tibiæ on dorsal side heavily marked with black and dark brown; abdomen ovate, very wide, widest slightly in front of middle, with broad transverse bands above and below, those above broken on disk except on eighth segment; large, clear spaces surrounding spiracles; genital band arched on eighth segment and with slender, dusky stripes running forward and slightly outward on seventh segment; ninth segment with short band or double spot.

This species is of the general type of *varius*, but much broader. In this respect it is similar to *latifasciatus* Piaget, described from *Xulla mantola*, but the clear spaces of the anterior part of the head are broader, the abdomen wider, the lateral bands extending farther toward the center, and circles around the spiracles larger, the head much more decidedly rounded in front, the clear spaces of clypeus and margin larger, and other characters indicating it to be a well-established form.

Described from one specimen collected from crow (*Corvus americanus*), at Ames, Iowa.

Nirmus picturatus n. sp.

Head elongate cordate, one hair visible each side, margined with black, apex clear, margin widening to base of antennæ, and from this point directed inward one-third width of head and then back to side of head; temporal lobes narrowly margined, occipital bands not blackened, occiput not margined; antennæ with joints subequal, annulate; prothorax or humeri in front and margin behind black; metathorax with broad, black band widened at sides to form submargin; legs strong, femora at base and tip and tibiæ at tip broadly annulate with black or dark brown; abdomen with broad, black margin on segments 1 to 7, broad ventral median bands on segments 1 to 5, faint on 1 and 2, not separated by median clear space, but with a transverse light band a little behind the middle of each dusky band; on segments 6 and 7 a continuous black patch, narrowing to posterior part of seventh, and continued as a narrow stripe to join the arc on the eighth segment in female and extended to tip of body in male; a few scattering hairs at the tip of the body, with some light portions laterally on seventh segment; seventh and eighth segments with dusky arc open in front, and eighth with a medial dusky spot and a marginal faint dusky spot; ninth unmarked, but indented at tip. The dorsal and ventral spots are not easily distinguished on account of thinness and transparency of body.

Taken from *Sturnella magna*, Ames, Iowa. Very closely related to *ornatissimus*, but differs distinctly from species on Agelaius and

Xanthocephalus in being a little larger, the clypeus more rounded internally, and in the absence of occipital bands, and in the median bands of abdomen not sharply defined.

Nirmus pallidus n. sp.

Almost white throughout. Head bluntly conic in front of antennæ, as long as wide; clypeus concave, a rather deep ventral furrow running from tip to mandibles; mandibles chestnut, a single hair at posterior angle of temporal lobes, widening behind; occiput convex, slightly emarginate in center; antennæ with basal joint larger than others, but short; second joint longest, fifth joint almost as long as second, third and fourth equal; prothorax rather narrow; metathorax broadened with lateral angles but little behind center and bearing several stiff hairs; posterior border subangulate, a few hairs toward the outer margin; legs uncolored, claws tinged with brown; abdomen elliptic, uncolored, sparsely hairy at sides posteriorly.

Taken from rose-breasted grosbeak (*Habia ludoviciana*), Ames, Iowa. All specimens, four in number, show the pallid character of immature individuals, but as the largest shows no more coloring than smallest, and all appear to have chitinous framework thoroughly developed, it seems proper to consider them fairly mature, at least. I can not connect them with any described species, and believe the above diagnosis will serve to distinguish them even if additional material should bring to light more mature specimens.

Nirmus secondarius n. sp.

Type *circumfasciati*. Head longer than wide, rounded in front and slightly conic; antennal band strong, thickened at margin; trabeculæ conic; antennæ rather long, first joint strong, second joint slender as long as third and fourth together; eyes prominent; temporal lobes narrowing behind, two hairs, one at middle of lateral margin the other at posterior angle; occiput slightly sinuous; thorax narrow; prothorax slightly widened behind, a strong bristle at posterior margin; metathorax contracted for one-third its length, widening behind; posterior margin regularly curved with stiff hairs set in pairs; legs strong, anterior femora with a prominent callosity at tip above; abdomen widest behind the middle, marginal bands strong, projecting deeply into preceding segment, and recurved in segments 1 to 5 and very slightly in segment 6; genital spot running from sixth segment to the tip and widening posteriorly. Color uniformly light brown, more prominent on margin of head; thorax and abdomen separated by clear lines on the sutures and by a median light line longitudinally in the front portion of the disk.

On *Corvus americanus*, Ames, Iowa.

Nirmus orpheus n. sp.

Head large, rounded in front, with continuous marginal band; antennæ slightly darker toward apex, eyes distinct; temporal lobes with blackish margin shading gradually toward the disk, with two hairs; occiput slightly concave; prothorax short, transverse; metathorax more than twice as long as prothorax, enlarging posteriorly; a hair at lateral angles; legs fuscous, somewhat more dusky on the dorsal border of femur and tibiæ; tip of femora subannulate; abdomen enlarging posteriorly, margin without deeper bands, median bands broad separated by wide, clear space on the sutures, those on the sixth, seventh, and eighth segments merging into a median stripe.

Length, 1.60 mm.; head, 0.5 mm.; abdomen, 0.9 mm. Width, head, 0.37 mm.; abdomen, 0.5 mm.

Described from two male specimens, both of which appear to be scarcely mature.

On *Galeoscoptes carolinensis.* Burnett collection.

Approaches the *Nirmus annulatus*, occurring on *Ceophlœus pileatus*, but lacks the annulations of the antennæ. The black margin to the abdomen and the median bands are differently arranged.

Nirmus tyrannus n. sp.

Yellowish brown, with darker margin to metathorax and abdomen.

Head conic, tapering sharply in front, but with rather broad truncate clypeus; antennæ inserted midway, second joint about as long as third, fourth, and fifth together; eyes prominent; occiput emarginate; thorax short; metathorax but little longer than prothorax; legs long, middle and posterior coxæ elongate; abdomen narrow, enlarging posteriorly, quite uniformly yellowish brown, with four hairs arising from minute, clear spots near the posterior margin of segments 3, 4, 5, 6, and 7. Also on the same segments are hairs arising just within the marginal band and one or two hairs at the lateral angles; spiracles located in clear spots just within the marginal band; eighth segment a transverse band, including two clear spots from which hairs arise; ninth segment very small.

Length, 2.6 mm. to 2.8 mm.; head, 0.7 mm.; abdomen, 1.68 mm. Width, head, 0.54 mm.; abdomen, 0.63 mm.

Described from two specimens (on *Tyrannus*) from the Burnett collection, both females.

Nirmus cordatus n. sp. (Pl II, fig. *a*).

Head cordate; abdomen ovate, tapering pretty sharply caudally. Color fulvous. Head regularly rounded in front; clypeal signature faint; antennæ inserted in front of the middle, rather thick; eyes large, prominent; occiput emarginate, with blackish border; temporal lobes with two hairs; prothorax short, a short hair on the angle; metathorax obtusely angled on the abdomen, two hairs at the lateral angle; legs strong, bright fulvous without bands; abdomen ovate, with transverse brown bands separated by clear spaces at the sutures, most distinct on the disk, a few short hairs at the angles of the posterior segments.

Length, 2.44 mm.; head, 0.66 mm.; abdomen, 1.41 mm. Width, head, 0.73 mm.; abdomen, 0.94 mm.

On *Limosa hæmastica*, Burnett collection.

Described from a single female specimen and an immature individual. The species, however, seems to be a well-marked one, and it seems proper to give it a description.

Nirmus marginatus n. sp. (Pl. II, fig. *b*).

Head and body with a blackish margin, gula with an inverted shield-shaped fuscous spot.

Head longer than wide; clypeus broad, rounded with a wide continuous band; antennæ with rather deep insertions; second joint about twice as long as the others, joints 3 to 5 with dusky annulations; occiput transverse, straight; prothorax short, rather deeply inserted in the head; metathorax twice the length of prothorax; posterior margin straight; lateral margin with blackish spots anteriorly and a larger fuscous patch posteriorly, with a prolongation inward to near the center; femora with a blackish dorsal spot extending into a partial annula; tibiæ with apical external spot and an internal black stripe; abdominal segments 1 to 7 with a black border and more or less distinct median transverse fuscous bands; eighth segment with a narrow fuscous band produced in front and with two clear pustules from which arise long slender hairs.

Length, 2 mm.; head, 0.56 mm. Width, head, 0.40 mm.; abdomen, 0.48 mm.

On *Ceophlœus pileatus*, Burnett collection.

Nirmus abruptus n. sp. (Pl. II, fig. *c*.)

Head parabaloid, almost conical in front, with a distinct ventral furrow in front of mandibles, outer margin deeply infuscated, becoming darker to the base of the antennæ; antennal pits surrounded by a broad, dark border, curved in front, straight behind, merging into a somewhat acute angle inwardly; antennæ obscurely annulate with fuscous, deepest on fourth and fifth joints, fifth joint nearly as long as third and fourth together; temporal lobes margined with a narrow black stripe, a single hair at the outer angle; occiput straight; prothorax small; metathorax about as broad as head, with deep stripes set into margin and merging into a transverse stripe; posterior margin set with a row of stiff hairs; legs robust; femur and tibiæ annulate at distal ends with fuscous and showing dorsally and ventrally deeper blackish spots; abdomen, with segments 1 to 7 with rather broad blackish margin within which the disk is light, clear, slightly yellowish and with a central row of transverse bands on ventral surface, those of the sixth and seventh segments merged together and connecting with the transverse stripe on the eighth segment, the lateral portions of which are curved forward; terminal segment slightly notched, a single series of hairs on the posterior margin of segments 5 to 8 and single hairs at the lateral angles on segments 3 to 7.

Length, 1.69 mm.; head 0.39 mm.; abdomen, 1.08 mm. Width, head 0.35 mm.; abdomen, 0.51 mm.

On *Colinus virginianus*, Burnett collection. Described from one mature ndividual, the slide also containing an immature one, which presents the same characteristics except in the intensity of the dark markings. This species is of the general aspect of *ornatissimus*, differing in the intensity of the abdominal margin and some of the head markings, and as it occurs on so distinct a group of birds it seems worthy of separate description.

Nirmus parallelus n. sp. (Pl. II, fig. *d*.)

Long and slender, recalling the form of *Lipeurus baculus*. Head long, slightly conic; clypeus wide, slightly convex; antennæ dusky at tip; forehead with a clear space in front of mandibles and a subquadrate clear space between the internal bands, but the anterior portion of clypeus dusky; orbital and temporal lobes strongly margined with black; prothorax quadrate, slightly narrowed in front; metathorax lobed at the sides; mesosternum, with central fuscous patch, emarginate in front, truncate behind, connected at sides with patches extending in from border; abdomen elongate, sides parallel, margins black; disk, with median brown patches, emarginate laterally, and separated at the sutures by transverse clear band; middle and posterior tibiæ, with a dark spot nearly encircling the tip, male similar to the female; terminal segment of abdomen rounded and dusky; genital hooks heavy, incurved.

♀ Length, 2 mm.; head, 0.42 mm.; width, head, 0.25 mm.; abdomen, 0.37 mm.

♂ Length, 1.74 mm.; width, abdomen, 1.74 mm.

On *Ægialitis vocifera*, Burnett collection. (Description written in May, 1894.)

This species is remarkably like the Lipeuri in appearance in the slender body and parallel-sided abdomen and the character of the legs, but there is no trace of a process upon the third joint of the antennæ or of the notch in terminal segment of male.

Kellogg's description of *Nirmus boephilus* from a female specimen from same host agrees quite closely in most respects, but differs in proportions of head. The types for my description being now in the Boston

Society of Natural History, a detailed comparison is impossible. Comparisons of a greater series of specimens will very likely prove their identity, in which case Kellogg's name will have priority. Kellogg's suggestion that this represents Packard's *Lipeurus gracilis* seems quite well founded.

Nirmus præstans Kellogg.

New Mallophaga, p. 99, Pl. V, figs. 1 and 2.

On royal tern, *Sterna maxima*, Monterey, Cal. (Kellogg).

Nirmus hebes Kellogg.

New Mallophaga, p. 101, Pl. V, fig. 3.

On royal tern, *Sterna maxima*, Monterey, Cal. (Kellogg).

Nirmus farallonii Kellogg.

New Mallophaga, p. 103, Pl. V, fig. 4.

On *Phalacrocorax dilophus albociliatus*, Monterey, Cal. (Kellogg).

Nirmus orarius Kellogg.

New Mallophaga, p. 104, Pl. V, fig. 5.

On *Charadrius dominicus*, Lawrence, Kans. (Kellogg).

Nirmus giganticola Kellogg.

New Mallophaga, p. 105, Pl. V, fig. 6.

On *Diomedea albatrus*, Monterey, Cal. (Kellogg).

Nirmus boephilus Kellogg.

New Mallophaga, p. 107, Pl. V, fig. 7.

On *Ægialitis vocifera*, Lawrence, Kans. (Kellogg).

Oncophorus minutus Nitzsch.

Nirmus minutus Giebel, p. 170, Pl. V, fig. 7.
Oncophorus minutus Piaget, p. 215, Pl. XVIII, fig. 2.

On *Fulica americana* Ames, Iowa.

Goniocotes rectangulatus Nitzsch.

Goniocotes rectangulatus Nitzsch, Germar's Mag., Vol. III, p. 294; Giebel, Epiz., p. 185.

I have not seen specimens of this species, but mention it here since it is so certain to occur here as well as in Europe.

Goniocotes hologaster Nitzsch.

Ricinus gallinæ De Geer, Vol. VII, Pl. IV, fig. 13.
Goniocotes hologaster Nitzsch, Germar's Mag , Vol. III, p 294; Giebel, Epiz., p. 184; Gurlt, Vol. VIII, Pl. IV, fig. 1; Piaget, Les Pédic., p. 231, Pl. XIX, fig. 6; Osborn, Bull. 7, Div. Ent., Dept. Agr., p. 32.

This is not the *G. hologaster* of Denny and of English and American writers generally, and I know of no positive record for America.

Goniocotes abdominalis Piaget.

Goniocotes hologaster Denny, p. 153, Pl. XII, fig. 4.
Goniocotes abdominalis Piaget, p. 238, Pl. XX, fig. 2; Osborn, Bull 7, Div. Ent., Dept. Agr., p. 32.

The species is usually known as *hologaster* in English and American writings.

Goniocotes compar Nitzsch.

Germar's Mag., Vol. III, p. 294; Denny, p. 152, Pl. XIII, fig. 2; Gurlt, Vol. VIII, p. 117, Pl. IV, fig. 2; Giebel, p. 183, Pl. XII, figs. 10 and 11, Pl. XX, fig. 8; Piaget, p. 234, Pl. XIX, fig. 10; Osborn, Bull. 7, Div. Ent., Dept. Agr., p. 33, fig. 19.

From *Columba livia*, specimens in Burnett collection.

Goniodes dispar Nitzsch.

Germar's Mag., Vol. III, p. 294; Denny, p. 159, Pl. XII, fig. 5; Giebel, Epiz., p. 193, Pl. XII, figs. 12, 13.

A specimen from the quail in the Cassino collection is referred to this species. I have not been able to critically compare it with *G. ortygis* of Piaget.

Goniodes cupido Giebel.

Zeitsch. f. ges. Naturwissensch., 1866, Vol. XXVIII, p. 387; Rudow, Zeitsch. f. ges. Naturwissensch., 1870, Vol. XXXV, p. 482; Piaget, Les Pédic., p. 250, Pl. XX, fig. 3.

From *Tympanuchus americanus*, C. B. Cook collection.

Goniodes merriamanus Packard.

Annual Report, U. S. Geol. and Geog. Survey, 1872, p. 731; Piaget, Les Pédic., p. 252 (cited).

I know of no record of this species later than the original description.

Goniodes damicornis Nitzsch.

Zeitsch. f. ges. Naturwissensch., 1866, Vol. XVII, p. 119; Giebel, Epiz., p. 197; Piaget, p. 255, Pl. XX, fig. 8; Osborn, Bull. 7, Div. Ent., Dept. Agr., p. 35, fig. 23.

Specimens from the pigeon in the Cassino collection.

Goniodes stylifer Nitzsch.

Pediculus meleagris Schrank, p. 504; *Goniodes stylifer* Nitzsch, Germar's Mag., Vol. III, p. 294; Denny, p. 156, Pl. XII, fig. 2; Giebel, Epiz., p. 200, Pl. XIII, fig. 1; Gurlt, Vol. VIII, p. 421, Pl. IV, figs. 7, 8; Piaget, p. 264, Pl. XXII, fig. 1; Osborn, Bull. 7, Div. Ent., Dept. Agr., p. 36, fig. 24.

Specimens from the turkey (*Meleagris galloparo*), collected by Dr. A. Hassall, Baltimore, Md.

Goniodes ortygis Piaget.

Les Pédic., p. 282, Pl. XXIII, fig. 6.

On *Colinus virginianus*, (vide Piaget.)

Goniodes falcicornis Nitzsch.

Pulex pavonis Redi, p. 14.

Pediculus pavonis Linné, Vol. II, p. 1019, 1765; Frisch, Ins., p. VIII, tab. 4; 1794 Fab., Syst. Ent. n. 27, p. 809 · Fab., Spec. Ins. p. II, p. 381; Fab., Mant. Ins. I, II, p. 370; Schrank, Ins. Aust.; Panzer, p. 51, fig. 19.

Nirmus tetragonocephalus Olfers, p. 9.

Goniodes falcicornis Nitzsch, Germar's Mag., Vol. III, p. 293.

Ricinus pavonis Kirby & Spence, Int. Ent., Vol. II, Pl. V, fig. 3.

Goniodes falcicornis Denny, p. 155, Pl. XII, figs. 1 and 2; Giebel, Epiz., p. 198, Pl. XII, figs, 14 and 15; *pavonis* Denning, Proc. Ray. Soc. Edinb., 1871, p. VII; Piaget, Les Pédic., p. 275, Pl. XXIII, fig. 1; Osborn, Bull. 7, Div. Ent., Dept. Agr., p. 36, fig. 25.

Common on the pea fowl.

Goniodes mephitidis Packard.

Rept. U. S. Geol. Survey, 1872, p. 732.

Not seen. It seems quite unlikely that a Goniodes should occur on a mammal except as a straggler, and I should incline to believe that the species is one of the forms occurring on the gallinaceous birds, and has possibly migrated to the skunk from its normal host when the latter was devoured.

Lipeurus heterographus Nitzsch.

Goniocotes burnetti Packard, American Naturalist, Vol. IV, p. 94; Osborn, Bull. 7, Div. Ent., Dept. Agr., p. 34, fig. 21.

In Burnett collection I find a species which agrees with Packard's description and figure, and which must, I think, be his *burnetti*, but it is not a Goniocotes, as I have specimens of both sexes, of what is evidently the same species, which prove it to be a Lipeurus.

Body margined distinctly with black. Head elongate, cordate; antennæ set in rather deeply; eyes conspicuous; antennal cavity and temporal lobes with black border extending inward to mandibles, also a prominent orbital band; occiput sinuous; prothorax subangular, lateral angles a little behind middle, with a single prominent hair; metathorax short, posterior border straight, lateral angles with three hairs, margin very black; legs rather slender; abdomen with black margin, and more or less distinct median bands, which are separated in median line and most distinct at the anterior and posterior borders.

On domestic fowl. Burnett collection, and Ames, Iowa. Specimens from Professor Bruner are from a young duck, and it seems probable that the species may occur on different domestic fowls where opportunity offers for its transfer from one to another.

Packard's figure (fig. 116, ante) is fairly good, though it lacks in detail for the certain recognition of the species.

Lipeurus baculus Nitzsch.

Pulex columbæ majoris Redi, Exp. pl. 2 (vide Denny); Louse of Pigeon, Albin, Aran. pl. 43.
Pediculus columbæ Linnæus.
Pediculus columbæ, Geoffry, Vol, II, n. 7, p. 599; Schrank, p. 114, n. 4, Tab. V., fig. 3; Fabricius Syst. Ent., n. 31, Spec. II, p. 482.
Nirmus filiformis; Olfers 90.
Lipeurus baculus, Nitzsch, Germar's Mag. Vol. III, p. 293; Lyonet, p. 273, Pl. XIII, fig. 10; Burmeister, Handbuch, Vol. II, p. 434, 8; Denny, p. 172, Pl. XIV, fig. 3; Gurlt, Vol. VIII, p. 424, Pl. VIII, fig. 9; Giebel, Epiz., p. 215, Taf. XVI, fig. 8, st. 9, Taf. XX, fig. 3; Giraud, Bulletin de la Soc. Ent., 1859; Piaget, Les Pédic., 303, Pl. XXV, fig. 2; Osborn, Bull. 7, Div. Ent., Dept. Agr., p. 38.

Very common on pigeons and evidently very general in distribution. Cassino collection, H. O. collection; Hassall collection, and C. B. Cook collection.

Lipeurus luridus Nitzsch (?).

Elongate, nearly parallel, general color dusky brown.

Head tapering in front of antennæ; clypeal suture indistinct, sides of head broadly margined; a large brown spot extending forward from the occiput, pointed anteriorly; antennæ of male with a very large basal joint, a much-curved third joint with the fourth joint set upon the outside of the curve; thorax quadrate, broadly margined with brown; metathorax trapezoidal, with four hairs near the posterior margin; legs large and strong; coxæ of second and third pair enlarged; abdomen widest about the middle, in the male light dusky bands running from side to side, occupying full length of the segments at margins; segments 4, 5, 6, and 7 with long hairs at lateral angles, spiracles surrounded by a small, clear circle.

I find it impossible to satisfy myself of the identity of my specimens from the American coot with the *luridus* of European authors The description given by Piaget and the figure (by Nitzsch) in Giebel are neither of them in accord with my specimens, and while Denny's figure might be made to fit, his description indicates blacker margin than in my specimens, and moreover, he does not seem to have been certain of his species, assuming it to be *luridus* from occurrence on the same bird. Therefore, while retaining the name with some doubt, I think it well to state the diagnostic features, and if additional material or comparison with European specimens prove it to be distinct, it will be time enough to give it a separate description and name.

Eurymetopus brevis Dufour.

(1835) *Philopterus brevis* Dufour, Annales de la Soc. Ent., Vol. IV, p. 674, Pl. XXXI, fig. 3. (vide Piaget, Les Pédic.).

(1839) *Lipeurus brevis* (*taurus* of Nitzsch MSS.) Burmeister, Handbuch, Vol. II, 433.

Lipeurus taurus, Nitzsch, Zeitschr. f. ges. Naturwissensch., (1866), Vol. XXVIII, p. 385 (vide Giebel).

(1864) *Docophoroides brevis* Giglioli, Quart. Jour. Micro. Sc., 1864, Vol. IV, p. 18, Pl. I.

Lipeurus taurus Piaget, Les Pédic., p. 332, Pl. XXXI, fig. 3.

Eurymetopus taurus Nitzsch. Taschenberg. Die Mallophagen (1882). p. 183, Pl. V, figs. 8 8a.

Lipeurus taurus Osborn, Proc. Nat. Museum, Vol. XII, p. 188.

It seems to me necessary to restore the name of Dufour for this species, as his description was published four years before any by Nitzsch, and in the first indication of the Nitzsch description (Burmeister. Handbuch II. p. 433) Dufour's name is given, and it is simply stated in parenthesis that it is the *taurus* of Nitzsch's MSS. On what ground Giebel should have resurrected the name *taurus*, or why Piaget should follow him in it, I fail to see, as both were familiar with Dufour's description.

Piaget considers the *L. pederiformis* of Dufour an example of *taurus* not fully developed (in way of development).

Lipeurus bifasciatus Piaget.

Les Pédiculines, p. 342, Pl. XXVIII, fig. 1.

From *Pelecanus erythrorhynchos*, Davenport, Nebr.: collection of Prof. Lawrence Bruner.

Lipeurus forficulatus N.

Zeitschr. fur ges. Naturwissensch. (Giebel Ed.). 1866, p. 386; Giebel. Insecta Epizoa. p. 238.

From pelican, Ames, Iowa. Recorded by Kellogg from *Pelecanus californicus* (Monterey, Cal.), and *Pelecanus erythrorhynchus* (Lawrence. Kans.).

Lipeurus temporalis Nitzsch.

Recorded by Kellogg, from *Merganser serrator* (Monterey, Cal.).

Lipeurus testaceus Tschb.

Recorded by Kellogg, from *Puffinus opisthomelas* (Monterey, Cal.).

Lipeurus toxoceros Nitzsch.

Recorded by Kellogg from *Phalacrocorax dilophus albociliatus* (Monterey, Cal.).

Lipeurus longicornis Piaget.

Albin, pl. 49 (?) (vide Piaget).

(?) *Lipeurus brevicornis* Denny, p. 181, Tab. XIII, fig. 8.

Lipeurus longicornis Piaget, Les Pédic., p. 334, Pl. XXVII, fig. 3.

This species occurred in great numbers upon a cormorant (*Phalacrocorax dilophus*), taken at Ames, Iowa.

Lipeurus squalidus Nitzsch.

Pediculus anatis Fab., Syst. Ent., p. 345.

Lipeurus squalidus Nitzsch, Germar's Mag., Vol. III, p. 292; Denny, p. 176, Pl. XVI, fig. 5; Grube Vol. II, p. 486; Giebel, p. 241, Pl. XVI, fig. 1; Piaget, p. 344, Pl. XXX, fig. 5; Osborn, Bull. 7, Div. Ent., Dept. Agr., p. 39, fig. 27.

Common to many kinds of ducks, specimens in Cassino collection from *Merganser serrator*. Stejneger Collection from *Eniconetta stelleri*. (H. O. collection, N. M. collection.)

Lipeurus variabilis Nitzsch.

Pediculus caponis, Linné, Syst. Nat., Vol. II, p. 1020, fig. 33; Faun. Suec., 1960.

Lipeurus variabilis Nitzsch, Germar's Mag., Vol. III, p. 292; Denny, p. 164, Pl. XV, fig. 6; Giebel, Epiz., p. 219, Pl. XVI, fig, 3; Gurlt, Vol. VIII, p. 422, Pl. VIII, fig. 10; Piaget, Les Pédic., p. 364, Pl. XXIX, fig. 4; Osborn, Bull. 7, Div. Ent., Dept. Agr., p. 41, fig. 29.

A common species on domestic fowls.

Lipeurus polytrapezius Nitzsch.

Pediculus meleagridis Linné, Syst. Nat., Vol. II, p 1020, fig. 31; Faun. Suec., 1958.

Lipeurus polytrapezius Nitzsch, Germar's Mag., Vol. III, p 293; Denny, p 165, Pl. XV, fig. 5; Giebel, p. 218, Pl. XVII, figs. 1 and 2; Gurlt, Vol. VIII, p. 423, Pl. IV. fig. 11; Piaget, p. 367, Pl. XXIX, fig. 6; Osborn, Bull 7, Div. Ent, Dept. Agr. p 41 fig 28,

The common Lipeurus of the turkey (*Meleagris gallopavo*). I have specimens collected from the wild turkey by Prof. H. W. Parker.

Lipeurus jejunus Nitzsch.

On *Anser albifrons gambeli* (Cook collection).

Lipeurus leucopygus, var. *fasciatus*.

On *Botaurus* sp. (Burnett collection).

Lipeurus pustulatus.

On "*Haliœtus leucocephalus*" (Burnett collection).

Lipeurus botauri, n. sp.

Slender, slightly marked with brownish, clypeus rugose. Head tapering; clypeus circular in front, with surface distinctly roughened with papilose rugosities, two hairs at the clypeal margin and two or three others on the margin of head in front of antennæ and two on temporal lobe; occiput slightly concave; prothorax slightly wider behind, tinged with brown at sides; metathorax quadrate, wider behind; posterior margin concave; legs large, anterior femora incrassate; abdomen with faint brownish markings on each segment, most conspicuous on segments 4, 5, and 6; angles of segments 3, 4, 5, 6, and 7 with short hairs.

On bittern or stake driver, *Botaurus leutiginosus*.

Lipeurus pullatus Nitzsch.

(1842) (?) *Lipeurus staphylinoides* Denny, Monog., p. 180, Pl. XV, fig. 2.
(1866) *Lipeurus pullatus* Nitzsch, Zeitschr. f. ges. Naturwissensch., Vol. XXVIII, p. 387.
(1872) *Lipeurus pullatus* Giebel, Epiz., p. 236.
(1880) *Lipeurus pullatus* Piaget, Les Pédic., p. 339, pl. XXVII, fig. 9.

On *Sula bassana* and *Sula alba*, Burnett collection (Nos. 91 and 92). Specimens labeled from *Sula alba* lighter colored than those from *Sula bassana*, but the latter agree perfectly with Piaget's excellent figure. It would seem that Denny's *staphylinoides* must come here, but the specimens do not agree with his description or figure.

Lipeurus infuscatus n. sp. (Pl. II, figs. *e*. and *f*.)

Light fuscous, a transverse clear space just behind the clypeus.

Female.—Head quite uniformly fuscous and elongate cordate, the anterior portion rounded, with a transverse clear space about one-third distance between the tip and antennæ extending to margins; antennæ rather long, second joint rather slightly longer than the others, all slightly fuscous; temporal lobes oval, narrowing posteriorly; occiput slightly concave; prothorax enlarging slightly behind, slightly darker at the margins, the usual bands not very distinctly marked; metathorax a little longer than prothorax, widening behind; legs unicolorous, the anterior ones with more distinctly marked apical ring to the femur and external marginal stripe on tibiæ; abdomen enlarging posteriorly, marginal bands rather broad, median bands extending to the clear spiracular spaces separated from each other by distinct sutural bands, a single row of hairs near the posterior margin and one or two hairs at the lateral angles of segments 4 to 8.

Male.—Head rounded in front, slightly conic, transverse clear space behind clypeus; antennæ strong, third joint produced on anterior margin, forming small but rather sharp process; abdomen nirmoid; legs strong.

Head elongate, slightly conic, widest behind antennæ, front rounded, nearly parabolic, the margins dense, a clear transverse band very distinct behind clypeus, one-third distance from tip to base of antennæ, mandibles conspicuous between bases of antennæ; antennæ strong, proximal joint enlarged, third joint slender, produced on anterior margin forming narrow rather acute process, distal joint longer than fourth, cylindric, 4 and 5 directed backward, being attached on caudad surface of third joint; eyes black, temporal lobes rounded narrowing caudad; occiput slightly emarginate; prothorax quadrate and widening slightly posteriorly; metathorax widening from prothorax to base of abdomen; anterior legs only about half as large as median pair, middle and hind legs large, coxæ not specially elongate but fairly elongate in hind pair; abdomen elongate ovate, widest segment behind the middle, with transverse brown bands, terminal segment scarcely notched, genital hooks slender.

♀ Length, 1.68 mm.; head, 0.48 mm.; abdomen, 0.98 mm. Width, head, 0.36 mm.; abdomen, 0.47 mm.

♂ Length, 1.64 mm.; head, 0.47 mm.; abdomen, 0.92 mm. Width, head, 0.34 mm.; abdomen, 0.43 mm.

This species, which is quite readily distinguished by the transverse clear space in the forehead, is represented by two females, one from *Philohela minor* and one from *Bartramia longicauda* and two males from *Bartramia longicauda* and one from *Philohela minor*, in the Burnett collection.

Lipeurus subangusticeps Piaget. (Pl. II, fig. *g*.)

Les Pédiculines, p. 308, Pl. XXV, fig. 5.

Male closely resembles the female in shape, but is somewhat smaller. The clypeus is slightly more pointed; the antennæ have the first joint very long, about as long as all the rest together, second joint as long as the remaining joints; third joint very short but with a distinct process on the anterior margin; fourth and fifth joints equal; terminal segment very slightly notched; genital hooks very long and slender.

♂ Length, 3.26 mm.; head, 0.70 mm.; thorax, 0.56 mm.; abdomen, 2 mm. Width, head, 0.30 mm.; abdomen, 0.33 mm.

♀ Length, 4 mm.

Described from one specimen in the Burnett collection, from *Thallassidroma wilsoni*, which contains also several fine specimens of the female. Heretofore only the female seems to have been discovered, and the above description is given to complete the description of the species. Some slight differences seem to exist when compared with the descriptions of Denny and Piaget, but these are only varietal at most.

Lipeurus densus Kellogg.

New Mallophaga, p. 114, Pl. VII, figs. 1 and 2.

On *Diomedea albatrus*, Monterey, Cal. (Kellogg).

Lipeurus varius Kellogg.

New Mallophaga, p. 116, Pl. VII, figs. 3 and 4.

On *Fulmarus glacialis glupischa* and *rodgersii*, Monterey, Cal. (Kellogg).

Lipeurus celer Kellogg.

New Mallophaga, p. 117, Pl. VII, figs. 5 and 6.

On *Fulmarus glacialis glupischa* and *rodgersii*, Monterey, Cal. (Kellogg).

Lipeurus longipilus Kellogg.
New Mallophaga, p. 119, Pl. VII, fig. 7.

On *Fulica americana*, Monterey, Cal. (Kellogg).

Lipeurus picturatus Kellogg.
New Mallophaga, p. 121, Pl. VIII, figs. 1 and 2.

On *Fulica americana*, Monterey, Cal. (Kellogg).

Lipeurus diversus Kellogg.
New Mallophaga, p. 123, Pl. VIII, figs. 3 and 4.

On *Puffinus opisthomelas*, Monterey, Cal. (Kellogg).

Lipeurus limitatus Kellogg.
New Mallophaga, p. 124, Pl. VIII, figs. 5 and 6.

On *Puffinus griseus*, Monterey, Cal. (Kellogg).

Lipeurus constrictus Kellogg.
New Mallophaga, p. 125, Pl. VIII, figs. 7 and 8.

On *Oidemia perspicillata* and *O. deglandi*, Monterey, Cal. (Kellogg).

Giebelia mirabilis Kellogg.
New Mallophaga, p. 138, Pl. XI, figs. 7 and 8.

On *Puffinus opisthomelas*, Monterey, Cal. (Kellogg).

Oncophorus advena Kellogg.
New Mallophaga, p. 133, Pl. XI, figs. 1 and 2.

On *Fulica americana*, Monterey, Cal. (Kellogg).

Ornithobius cygni Linn.
Pulex cygni Redi, Exp. tab. 8, Oper., tab. 20.
Louse of the swan, Albin, Aran., p. 76, tab. 48.
Pediculus cygni Linné, Syst. Nat., Vol. II, p. 1018.
Pediculus cygni Fab., Syst. Ent., p. 807, fig. 18.
Ornithobius cygni Denny, p. 183, Pl. XXIII, fig. 1.
Lipeurus bucephalus Giebel, Epiz., p. 239.
Ornithobius bucephalus Piaget, Les Pédic., p. 377, Pl. XXXI, fig. 4.
Ornithobius bucephalus Osborn, Bull. 7, Div. Ent., Dept. Agr., p. 42, fig. 30.

Collected in abundance from a swan, probably *Olor buccinator*, at Ames, Iowa.

It seems to me necessary, on the ground of priority, to retain the name given by Linnæus, and while in my previous papers I have followed Piaget in accepting Giebel's name, it was simply to avoid confusion and in deference to his authority. In the present paper, and with the synonomy stated in full, it seems best to restore the early name. While certainly recognized by Redi and Albin, Linnæus was the first to properly describe it.

Ornithobius goniopleurus.

On *Branta canadensis*, Burnett collection.

Trichodectes latus Nitzsch.
Ricinus canis De Geer, Vol. VII, Tab. IV, fig. 13.
Pediculus setosus Olfers, p. 84.
Trichodectes latus Nitzsch, Germar's Mag., Vol. III, p. 296; Burmeister, Vol. II, p. 436; Denny, p. 188, Pl. XVII, fig. 1; Gurlt, Vol. IX, p. 2, Pl. I, fig. 1; Giebel, p. 53, Pl. III, figs. 2 and 3; Piaget, p. 384, Pl. XXXI, fig. 6; Osborn, Bull. 7, Div. Ent., Dept. Agr., p. 43, fig. 32.

A common species upon the domestic dog. It has had frequent mention in general works upon parasites. Specimens in the Hassall collection, labeled 1884, may have been taken in England.

Trichodectes subrostratus Nitzsch.

Germar's Mag., Vol. III, p. 296; Giebel. Zeitschr., Vol. XVII, p. 88, Pl. I, figs. 4, 5, and 6; Gurlt, Vol. IX, p. 6; Giebel. Epiz., p. 55. Pl. III, fig. 5; Piaget, p. 389, Pl. XXXI, fig. 9; Osborn, Bull. 7, Div. Ent., Dept. Agr., p. 42, fig. 31.

The common louse affecting domestic cats, often abundant. I have specimens from the Fitch and various other American collections.

Trichodectes retusus Nitzsch.

Pediculus mustelæ Schrank.
Trichodectes retusus Nitzsch, Germar's Mag., Vol. III, p. 296.
Trichodectes dubius Nitzsch, Germar's Mag., Vol. III, p. 296.
Trichodectes dubius Denny, p. 190, Pl. XVII, fig. 2.
Trichodectes retusus Giebel, p. 55, Pl. III, fig. 4.
Trichodectes pusillus Giebel, p. 55, Pl. III, fig. 4.
Trichodectes retusus Piaget, p. 387, Pl. XXXI, fig. 8.

Collected from a weasel at Ames, Iowa, July, 1883.

Specimens evidently belonging here and taken from the mink have been examined in collections from Professor Bruner and Professor Comstock. In the Bruner collection there is a very fine series of females which agree closely with descriptions and figures by Piaget, but, unfortunately, there appear to be no mature males. A single mature male in the Cornell collection, however, agrees with the male from the weasel, and I therefore feel little hesitancy in referring all to *retusus*.

Trichodectes crassus Nitzsch.

I have referred here, with some hesitation, a specimen from the raccoon (*Procyon lotor*) (Burnett collection.) The specimen was not in condition for absolute identification.

Trichodectes climax Nitzsch.

Trichodectes climax Nitzsch, Germar's Mag., Vol. III, p. 296; Gervais, Vol. III, p. 313, pl. 48, fig. 3; Giebel, Zeitschr., Vol. XVII, p. 81, pl. 1, figs. 1 and 2; Giebel, Epiz., p. 58, pl. XX, fig. 2.
Trichodectes capræ Gurlt, Vol. IX, p. 3, Pl. I, fig. 2; Packard's Guide, p. 555.
Trichodectes climax Piaget, p. 391, Pl. XXXII, fig. 1; Curtice, Anim. Par. Sheep, Bur. Animal Industry, Dept. Agr., p. 30, Pl. VI; Osborn, Bull. 7, Div. Ent., Dept. Agr., p. 44.

Infests the common goat. Specimens in Hassall collection, collected at Baltimore 1891. This and the following one are very similar.

Trichodectes limbatus Gervais.

Trichodectes limbatus Gervais, Aptera, Vol. III, p. 313, Pl. VII, fig. 1; Giebel, Epiz., p. 57; Piaget, Les Pédic., p. 395.
Trichodectes climax var. *major* Piaget, Les Pédic., Suppl., p. 86, Pl. IX, fig. 5.
Trichodectes limbatus Curtice, Anim. Par. Sheep, Bur. Animal Industry, Dept. Agr., p. 49, Pl. VI; Osborn, Bull. 7, Div. Ent., Dept. Agr., p. 44.

This form so closely resembles the *climax* that it has been a question whether it is entitled to specific rank. Specimens in Hassall collection taken at Baltimore in 1891. (See figure, ante.)

Trichodectes sphærocephalus Nitzsch.

Figured Redi, Pl. 22.
Pediculus ovis Linné, Syst. Nat. II, p. 1017; Schrank, p. 502, Pl. I, figs. 8 and 9.
Trichodectes sphærocephalus Nitzsch. Germar's Mag., Vol. III, 296; Denny, p. 193, Pl. XVII, fig. 4; Gurlt, Vol. IX, p. 5; Giebel, Epiz., p. 60; Piaget, p. 393, Pl. XXXII, fig. 2; Curtice, Anim. Par. Sheep, Bur. Animal Industry, Dept. Agr., p. 45, Pl. V; Osborn, Bull. 7, Div. Ent., p. 45.

A rather common parasite on sheep, though seldom in great numbers. Specimens in H. O. collection from Canada and Iowa. Has been quite common on sheep at Ames, winter of 1895–6.

Trichodectes scalaris Nitzsch.

Pediculus bovis Linné, Syst. Nat., II, p. 1017; *tauri* Linné, Faun. Suec., p. 1946; *tauri* Fab., Spec. Ins., Vol. II, p. 477.

Trichodectes scalaris Nitzsch, Germar's Mag., Vol. III, p. 296; Denny, p. 191, Pl. XVII, fig. 9; Giebel, p. 61, Pl. III, figs. 7 and 9; Piaget, p. 396, Pl. XXXIII, fig. 2.

A very common parasite on domestic cattle, and I have seen specimens in a number of collections. Although there can be little doubt that Linnæus referred to this form in his descriptions of *P. bovis* and *P. tauri*, the mistaken generic reference and the indefiniteness of his description may be reason to give Nitzsch's name the precedence, and I have followed all modern authors in so referring it.

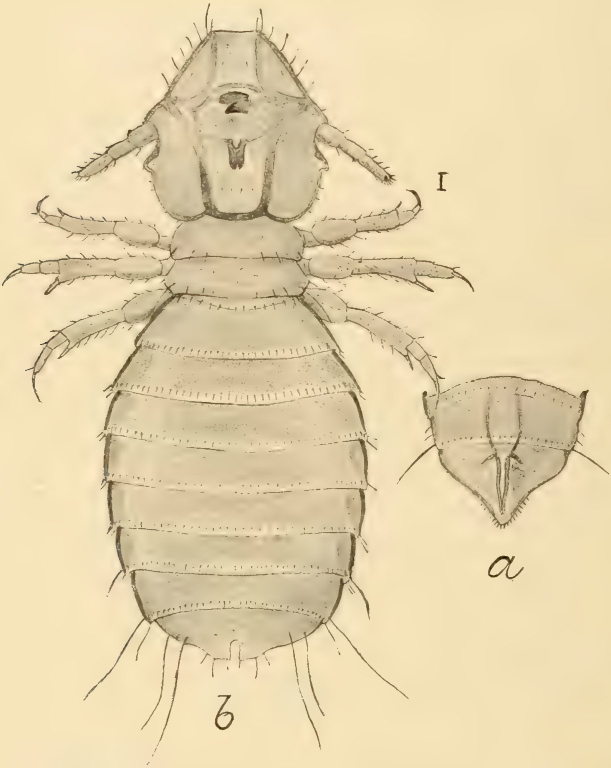


Fig. 145.—*Trichodectes setosus*: *a*, terminal segments of male; *b*, female—enlarged (original).

Trichodectes parumpilosus Piaget.

Trichodectes equi Denny, p. 191, Pl. XVII, fig. 7.

Trichodectes parumpilosus Piaget, p. 397, Pl. XXXII, fig. 5.

Trichodectes parumpilosus Osborn, Bull. 7, Div. Ent., Dept. Agr., p. 46, fig. 35.

This species is the common one of horses in this country, and is the one which in English and American works generally, since Denny's monograph, has been known as *Trichodectes equi*.

Specimens collected abundantly at Ames, Iowa, and I have determined it in a number of collections.

Trichodectes pilosus Giebel.

Pediculus equi Linné, Syst. Nat. II, p. 1018; Gurlt, Vol. IX, p. 5 (vide Piaget).
Trichodectes pilosus Giebel, Zeitschr. f. ges. Naturwissensch., 1861, Vol. XVII, p. 86; Giebel, Epiz., p. 59; Piaget, p. 395, Pl. XXVII, fig. 4; Osborn, Bull. 7, Div. Ent., Dept. Agr., p. 45, fig. 34.

Piaget holds that this is the form originally described as *Pediculus equi* by Linnæus, but retains the name proposed by Giebel. He records it as occurring on both *Equus caballus* and *Equus asinus*. I am not aware of any record of actual occurrence of this form in this country, but it should be found on donkeys and horses, and it seems proper to include it with such statement.

Trichodectes setosus Giebel.

Collected from porcupine (*Erethizon dorsatum*) by Prof. Lawrence Bruner, Lincoln, Nebr.

Trichodectes geomydis Osborn.

Bull. 7, Div. Ent., Dept. Agr., p. 54, fig. 42.

A very common and abundant species on the pocket gopher (*Geomys bursarius*), and I have examined specimens in the Cassino collection from Thomomys. Also from *T. bottæ*, from California, in Johnson collection.

The original notice and description are as follows:

Related to the Trichodectes infesting the larger mammals is a species which has been taken in immense numbers from the pocket gopher (*Geomys bursarius*), at Ames, Iowa. It was first taken in 1883, and since then has been collected from a great number of individuals, and I have also seen specimens taken from the western gopher, *Thomomys*, in a collection of parasites kindly loaned me by Mr. S. E. Cassino.

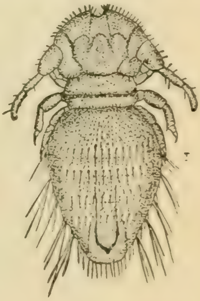


FIG. 146. — *Trichodectes geomydis* — enlarged (author's illustration).

Body robust and rather hairy. Antennæ very long, the basal segment enlarged, the head with a deep semicircular incision in front.

The head is rather wider than long and the antennæ are situated somewhat posterior to the middle and usually directed backward, very large and long, the joints nearly equal in length, but the basal are much enlarged in the male. Head with a deep semicircular incision on the otherwise semicircular anterior border, the posterior border slightly trilobed. Thorax short and broad; suture distinct; abdomen ovate, tapering regularly and rapidly to the anal segment. Genital apparatus of male distinct. The hairs are distributed evenly over border of head and sides of body; four central segments of abdomen with transverse rows of stronger hairs or weak spines, and the lateral posterior angles of all segments but the first with long bristles. Length, 1 mm.

The antennæ in male and the deep frontal incision separate this from any species known to me, and I think there is no question as to its being a distinct species.

Trichodectes tibialis Piaget.

Les Pédiculines, p. 399, Pl. XXXII, fig. 6.

I have referred to this species some specimens from the black-tailed deer (Baker collection).

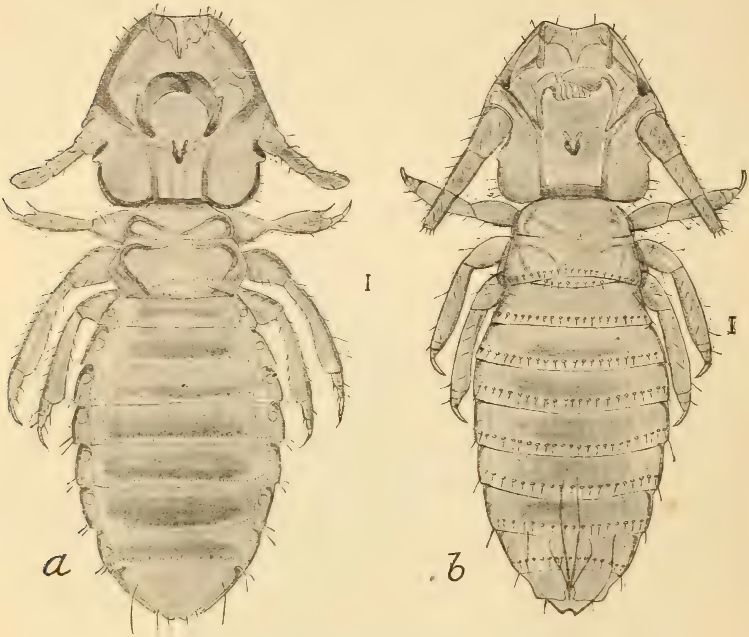


FIG. 147.—*Trichodectes tibialis: a*, female; *b*, male—enlarged (original).

They do not agree absolutely with Piaget's description or figure, but until a more critical study can be made or additional material collected it may rest here.

Trichodectes parallelus n. sp.

Head large, abdomen rather narrow, hind border mesothorax and metathorax straight.

Head large, clypeus slightly concave, a few short hairs on front border, antennal angles very prominent; antennæ long, reaching beyond hind border of head, first joint slightly enlarged, second and third about equal, third slightly curved; temporal lobes quadrate; lateral angles rounded; occiput straight; occipital bands parallel.

Prothorax and metathorax equal in length, metathorax a little wider, prothorax with sides curved; metathorax with sides straight; in both, posterior border straight.

Legs slender, claws long, slender.

Abdomen narrow, entirely corneous, segments straight and equal, no dusky transverse bands, spiracles conspicuous on 2 to 7, bordered especially in front with dark brown or blackish; hairs at

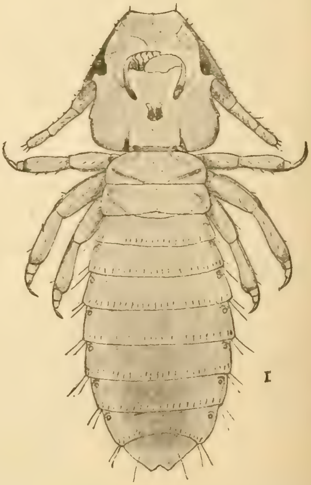


FIG. 148.—*Trichodectes parallelus:* female—enlarged (original).

angles, short, a row of fine ciliate hairs near posterior border of metathorax and each abdominal segment except last; claspers or brushes small or wanting.

Length, 1.70 mm.

Described from three specimens (females) from deer, collection Cornell University, kindly loaned by Prof. J. H. Comstock. Comes nearer to *tibialis* Piaget than any other species, but differs from that in narrowness of abdomen, lack of transverse bands upon metathorax, etc., and while possibly it could be referred to some of the species from deer of Europe, it seems safer to give it a new description than to increase the confusion regarding the European species affecting deer. Species of deer is not given, but probably Virginia deer (*Cariacus virginianus*) is meant.

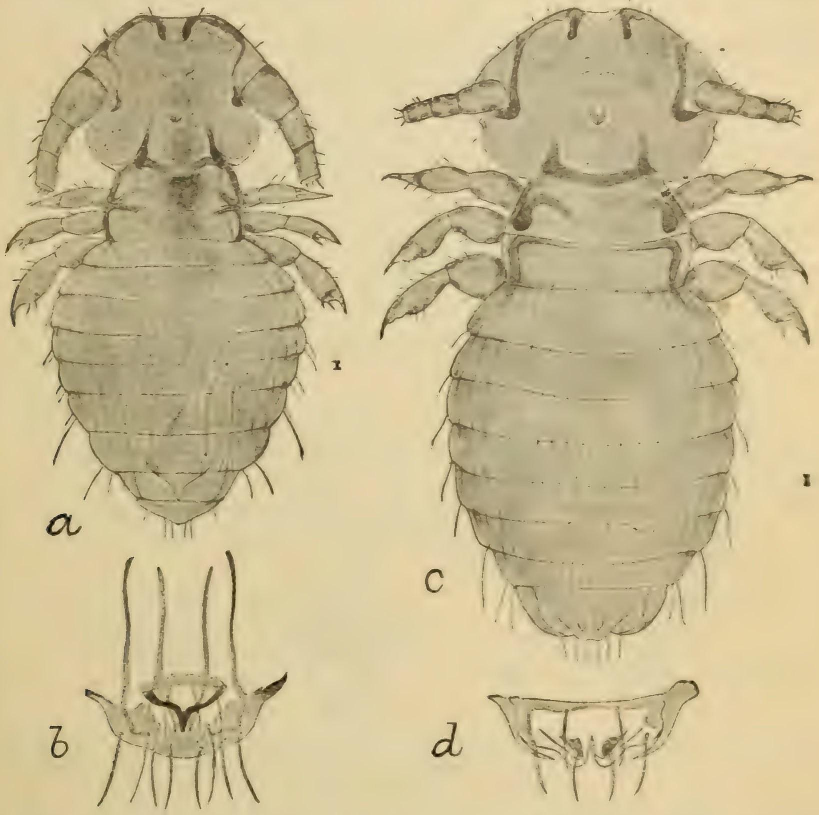


FIG. 149.—*Trichodectes castoris*: *a*, male; *b*, male terminal segment and genitalia; *c*, female; *d* terminal segment—enlarged (original).

Trichodectes castoris, n. sp.

Short, broad; head wider than long. Antennæ of male enlarged.

Head wide, antennæ deeply set, front border regularly convex, not hairy, apex with shallow, curved incision, with transparent space running backward.

Antennæ long, proximal joint in male enlarged, distal joint with sensory hairs on outer tip; temporal lobes full, not angulate; occiput strongly convex; abdomen membranous ovate, with slender, curved hooks on eighth segment in female and conspicuous genital apparatus in male.

Length, male, 0.95 mm.; female, 1.15 mm.

From beaver, collected by Prof. Lawrence Bruner. This species simulates both *geomydis* and *mephitidis*, and were it not for the wide separation of the beaver and skunk I might be tempted to consider them the same. There appears, however, some pretty constant differences. The shallowness of the frontal hollow separates it easily from *geomydis*, and the form of head and greater length of female antennæ from *mephitidis*.

Trichodectes mephitidis n. sp.

Short and broad, male antennæ large, front slightly excised.

Female, head wider than long, transversely oval, front regularly curved, slightly excised at apex, the space directly behind the excision transparent, and the internal bands coming to a prominent right angle at each side of hollowed portion.

Temporal lobes rounded posteriorly, no angle; occiput convex, a few short hairs on posterior lateral border of head, none on front; thorax very short; legs as usual; abdomen without transverse bands or chitinous structures, except a pair of curved hooks on eighth segment at outer margin; scattering hairs, thickest on central portion.

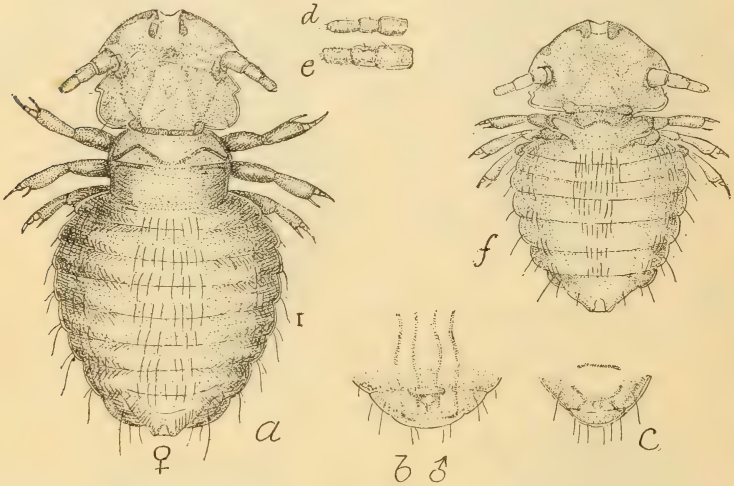


FIG. 150.—*Trichodectes mephitidis*: *a*, female; *b*, terminal segments, male; *c*, terminal segment, female; *d*, antennæ, female; *e*, antennæ, male; *f*, young—enlarged (original).

Male with frontal incision deeper, some very minute hairs on front edge. Antennæ much larger than in female, basal joint enlarged, terminal joint curved, short hairs on outer part near tip; abdomen tapering, membranous, not banded, stiff hairs at angles and on the terminal segment, finer hairs on disk; genital apparatus conspicuous. Immature specimens have the frontal incision more conspicuous.

Length, female, 1.20 mm.; male, 0.95 mm.

Collected from polecat (*Spilogale interrupta*), Tama County, Iowa. Numerous specimens from the skunk (*Mephitis mephitica*) collected by Lawrence Bruner, Holt County, Nebr.; also from Palo Alto, Cal.

(Johnson collection). This species is allied to the *T. retusus* occurring on weasel, etc., and also to *T. geomydis* on pocket gopher, but differs from the former in form of front of head, the absence of bands, size of male antennæ, temporal lobes, and other characters which make it easy of separation. The same species, apparently, also collected from the ringtail cat (*Bassariscus astuta*), Lake County, Cal. (Johnson collection).

Family LIOTHEIDÆ.

Menopon rusticum Giebel.

Giebel, Epiz., p. 288; Piaget, Les Pédic., p. 443, Pl. XXXVI, fig. 2.

Occurred in large numbers on a house martin (*Progne subis*), at Ames, Iowa.

Menopon pallidum Nitzsch.

Pulex capi Redi, Tab. XVI, fig. 1 (vide Piaget).
Pediculus gallinæ Linné, Syst. Nat. II, p. 1023, probably; Panzer, p. 51, fig. 21 (vide Piaget); Geoffroy, Vol. II, p. 601.
Nirmus trigonocephalus Olfers, p. 90.
Menopon pallidum Denny, p. 217, Pl. XXI, fig. 5; Gurlt, Vol. VIII, p. 428, Taf. IV, fig. 14; Giebel, p. 291, Pl. XVII, fig. 11, and Pl. XIX, figs. 2 and 5; Piaget, p. 459, Pl. XXXVII, fig. 7; Osborn, Bull. 7, Div. Ent., Dept. Agr.

A universal parasite of the domestic fowl. I have examined many specimens in different collections, and have seen and collected it on many occasions myself.

Menopon biseriatum Piaget.

Piaget, Les Pédic. p. 469, Pl. XXXVII, fig. 2.

Collected at Baltimore, from domestic fowl, by Dr. A. Hassall. Also in Cornell University collection. It appears to be less common than the preceding, though often associated with it, and probably generally mistaken for large specimens of that species.

Menopon titan Piaget.

Les Pédiculines, 1880, p. 503, Pl. XI, fig. 7.
Tetraophthalmus chilensis Grosse, Zeit. f. w. Zool., 1885, Vol. XIII, p. 530.
Menopon titan Kellogg, New Mallophaga, p. 163.

Recorded by Kellogg from *Pelicanus californicus*. He proposes three varieties to represent the species.

Menopon consanguineum Piaget.

(?) *Menopon perale* Leidy, Proc. Acad. Nat. Sci. Phila., 1878, p. 100.
Menopon consanguineum Piaget, Les Pédic., Suppl., p. 116, Pl. XII, fig. 7.

Occurs in great numbers in buccal cavity of pelican. Has been collected at Ames, Iowa, and specimens examined in collections of National Museum, Kansas University, Boston Society of Natural History, etc. A record of its occurrence has been given in Insect Life, V, p. 284.

Also recorded by Kellogg as var. *impar* of *titan* (?) New Mallophaga, Proc. Ac. Sci. Cal., series 2, Vol. VI (1896).

It seems to me the variations exhibited in this species may be due to its peculiar habit and the probability that this habit is of recent origin.

Menopon pallescens Nitzsch.

Menopon perdicis Denny, Monog., p. 225, Pl. XXI, fig. 9.
Menopon pallescens Ztschr. für ges. Naturwissensch., 1866, Vol. XXVIII, p. 391; Giebel, Epiz., p. 293.

One male and one larva. Burnett collection. From "*Perdix americana*" (*Colinus virginianus).*

Nitzsch described the species from specimens taken from *Caccabis rufa.* Denny's description would seem to have priority. He says common on the partridge (*Perdix cinerea*).

Menopon tridens Nitzsch.

Menopon tridens Burmeister, Handbuch, Vol. II, p. 440.

Læmobothrum tridens Nitzsch, Ztschr. f. ges. Naturwissensch., 1866, Vol. XXVIII, p. 396 (vide Giebel).

Menopon scopulacorne Denny, Monog., p. 221, Pl. XXVIII, fig. 9.

Menopon tridens Giebel, Epiz., p. 296, Pl. XVII, fig. 9.

Menopon tridens Piaget, Les Pédic., p. 479, Pl. XXXIX, fig. 1.

From coot (*Fulica americana*), Ames, Iowa. Agrees closely with European description, except that abdomen appears broader than figured. The peculiar structure running forward from occiput beneath seems to be characteristic. Also in Burnett collection.

Recorded by Kellogg, who suggests three varieties to include the American forms, (New Mallophaga, p. 165).

Menopon crassipes Piaget.

Les Pédiculines, p. 450, Pl. XXXV, fig. 7.

A specimen which I refer to this species is from the Baltimore oriole, (*Icterus galbula*) (Burnett collection).

Menopon carduelis Denny.

Monog. Anop. Brit., p. 228, Pl. XX, fig. 7.

On *Spinus tristis* (Burnett collection).

Menopon fulvo-fasciatum Piaget.

Les Pédiculines, p. 417, Pl. XXXIII, fig. 3.

On *Milvus* sp. incog. (Burnett collection).

Menopon crocatum Nitzsch.

Giebel, Insecta Epizoa, p. 295; Piaget, Les Pédic., p. 47, Pl. XXXIX, fig. 3.

On *Philohela minor* and *Limosa hæmastica* (Burnett collection).

Menopon navigans Kellogg.

New Mallophaga, p. 156, Pl. XIV, figs. 4 and 5.

On short-tailed albatross, Monterey, Cal. (Kellogg).

Menopon indistinctum Kellogg.

New Mallophaga, p. 157, Pl. XIV, figs. 6 and 7.

From American avocet (*Recurvirostra americana*), Lawrence, Kans. (Kellogg).

Menopon numerosum Kellogg.

New Mallophaga, p. 159, Pl. XV, fig. 1.

From Pacific fulmars (*Fulmarus glacialis glupischa* and *rodgersii*), Monterey, Cal. (Kellogg).

Menopon infrequens Kellogg.

New Mallophaga, p. 161, Pl. XV, fig. 5.

On *Larus glaucescens*, Monterey, Cal. (Kellogg).

Menopon loomisii Kellogg.

New Mallophaga, p. 162, Pl. XV, fig. 6.

On white-winged scoter (*Oidemia deglandi*), Bay of Monterey (Kellogg).

Menopon expansum n. sp. (Pl. II, fig. *j*).

Abdomen very broad, ovate. Head with a sinuous margin and very deeply emarginate occiput; orbital sinus entirely covered; temporal lobes with two long bristles and two or three short hairs; prothorax nearly as broad as head and closely fitting into the occipital cavity, the lateral angles in contact with temporal lobes; posterior margin semicircular; metathorax short, rounded in front, with two bristles at the lateral angles; legs robust, femora very large, irregularly set with short hairs; abdomen nearly as broad as long, uniformly yellowish brown, margins of segments above with a closely set series of hairs which are longer at the lateral angles posteriorly, and the entire ventral surface irregularly set with short hairs arising from minute clear pustules.

Length, 1.31 mm.; head, 0.18 mm.; abdomen, 0.80 mm. Width, head, 0.47 mm.; abdomen, 0.80 mm.

On *Dolichonyx oryzivorus*. Burnett collection (No. 67). Distinguished by the extreme width of the abdomen.

Menopon interruptus n. sp. (Pl. II, fig. *h*).

Light yellow, with conspicuous dark-brown bands and black lines. Abdominal bands of female broken and irregular near margin of segments 3 and 5. Legs strong, lined with black.

Head semicircular in front, a few hairs on margin, antennæ scarcely passing margin of head, orbital pits deep, fringed with hairs behind; temporal lobes rounded, three long bristles arising from circular clear spots, dark brown on front, each side connecting with orbital black spot, temporal margin deeply infuscated occipitally; prothorax with sharp lateral angles broader than long, posterior margin rounded; metathorax broad and long, widening rapidly behind, posterior margin rounded, produced over abdomen, sides deep brown; sternal markings, on prothorax a brown patch broadening in front, acute behind, and with the blunt process behind the posterior lateral portion expanding and connecting with fuscous bands that extend latero-cephalad to the margin; on mesothorax a central pentagonal patch extending in fuscous bands postero-laterally and laterally; on metathorax a subtriangular patch acutely angled behind, slightly convex in front; legs with enlarged femora, blackish border externally on femora and tibiæ, and blackish annulæ at the apical end of tibiæ; proximal joint of tarsus with an enlarged membranous disk; abdomen with sides somewhat parallel and heavy transverse bands, which in female are interrupted and dislocated upon the third to fifth segments, but particularly upon the fourth.

Apparently a very common species upon the American crow (*Corvus americanus*). A number of specimens in the Burnett collection. Also collected at Ames, Iowa.

Menopon fusco-marginatus n. sp.

Head with rather deep orbital sinus, a large fuscous patch beneath with bands running latero-cephalad to the orbital sinus and posteriorly along the gular margin; prothorax with a miter-shaped sternal plate; abdomen with broad lateral fuscous margin, head rounded in front with scattering slender hairs, palpi reaching to the margin of the head; antennæ barely visible, the orbital sinus beneath margined with stiff hairs and with a dark-brown border; temporal lobes broad, bearing three long bristles, head beneath with large brown patch forked in front, the branches extending to the orbital sinus and thence connecting with the brown spots at lateral margin of clypeus; prothorax broad, closely joined to head, posterior margin rounded beneath with an acuminate miter-shaped sternal plate and dark-brown bands; metathorax enlarging behind, legs strong, marked with brown, the distal portions of femora and tibiæ annulate with dark fuscous; abdomen oval, margin broadly fuscous, fuscous bands crossing the disk but uniting into a long brown patch upon the seventh, eighth, and ninth segments; posterior margin of the segments with a row of short hairs most conspicuous on the lateral dense portion. Male somewhat similar to the female with a brown patch on the abdomen, including only the eighth and ninth segments.

♀ Length, 1.73 mm; head, 0.32 mm; abdomen, 1.03 mm. Width, head, 0.50 mm; abdomen, 0.63 mm.

♂ Length, 1.41 mm; head, 0.35 mm; abdomen, 0.70 mm. Width, head, 0.47 mm; abdomen, 0.51 mm.

On "*Turdus minor*" in Burnett collection. This species approaches the *Menopon interruptus* occurring on the common crow, but differs distinctly in the patch on the under side of the head, sternal plate, and especially the abdominal bands, which are not interrupted as in that species.

Ancistrona gigas Piaget.

Les Pédiculines, Suppl., 1885, p. 117, Pl. XII, fig. 8; Kellogg, New Mallophaga, p. 150.

This species is recorded by Kellogg, as collected from the Pacific fulmar, *Fulmarus glacialis rodgersii* and *glupischa*, Bay of Monterey, California.

Colpocephalum pustulosum Piag.

Les Pédiculines, p. 559, Pl. XLVI, fig. 8.

On kingfisher, *Ceryle alcyon* (Burnett collection).

Colpocephalum subpachygaster Piaget.

Les Pédiculines, p. 517, Pl. XLIII, fig. 2.

On *Bubo virginianus* (Burnett collection.).

Colpocephalum flavescens Nitzsch.

Nitzsch, Germar's Mag., Vol. III, p. 298; Lyonet, p. 262, Pl. XII, fig. 2; Denny, p. 206, Pl. XVIII, fig. 2; Giebel, p. 262, Pl. XIII, fig. 10, and Pl. XIX, figs. 3, 4, and 7; Piaget, Les Pédic., p. 515, Pl. XLII, fig. 10.

A common species on various birds of prey. Collected from swallow-tailed kite, Ames, Iowa. Other authors have cited it from a large number of rapacious birds.

Colpocephalum longicaudum Piaget.

Les Pédiculines, p. 534, Pl. XLIV, fig. 6.

On carrier pigeon (Burnett collection). Also a specimen very similar on *Gallus gallus*. (Burnett collection).

Colpocephalum ochraceum Nitzsch.

A specimen which agrees very closely with this species is credited to *Tringa maculata* in the Burnett collection.

Colpocephalum assimile Piaget.

Les Pédiculines, p. 544.

Described from specimens taken from *Grus americana* in zoological garden at Rotterdam. Also collected at Ames, Iowa (H. O. collection). Also on whooping crane, Lamar, Colo. (Gillette).

Colpocephalum fuscipes Piaget.

Les Pédiculines, p. 567, Pl. XLVII.

From gull, *Larus* sp. in the Cassino collection.

Colpocephalum unciferum Kellogg.

New Mallophaga, p. 140, Pl. XII, figs. 1, 2, and 3.

On *Pelecanus californicus*, Monterey, Cal. (Kellogg).

Colpocephalum uniforme Kellogg.

New Mallophaga, p. 142, Pl. XII, fig. 4.

On American avocet (*Recurvirostra americana*), Lawrence, Kans. (Kellogg).

Colpocephalum pingue Kellogg.

New Mallophaga, p. 144, Pl. XII, fig. 5.

On short-tailed albatross (*Diomedia albatrus*) (Kellogg).

Copocephalum timidum Kellogg.

New Mallophaga, p. 145, Pl. XII, fig. 6.

On golden plover (*Charadrius dominicus*), Lawrence, Kans. (Kellogg).

Colpocephalum laticeps Kellogg.

New Mallophaga, p. 149, Pl. XII, fig. 8.

On *Ardea egretta*, Lawrence, Kans. (Kellogg).

Colpocephalum funebre Kellogg.

New Mallophaga, p. 147.

From *Larus glaucescens*, Monterey, Cal.

Nitzschia pulicaris Nitzsch.

Nitzschia burmeisteri Denny, p. 230, Pl. XXII, fig. 5.
Menopon pulicare Giebel, p. 290.
Nitzschia pulicaris Piaget, p. 574, Pl. XLVIII, fig. 6; Osborn, Can., Ent. (record); Osborn, Insect Life (period of incubation).

Common on chimney swift. Collected at Ames, Iowa.

Læmobothrium atrum Nitzsch.

Pulex fulicæ Redi, Exp., Table IV, fig. 1.
Louse of the Coot, Albin., Aran., pl. 44.
Læmobothrium atrum Nitzsch, Germar's Mag., Vol. III, p. 302.
Læmobothrium nigrum Burmeister, Handbuch, Vol. II, p. 442.
Læmobothrium atrum Denny, p. 240; Giebel, p. 253, Pl. XVIII, fig. 5; Piaget, p. 586.

A specimen of this well-marked species was in a small collection of Mallophagidæ sent me for determination from Mr. Ph. Laurent, of Philadelphia.

Also recorded by Kellogg (New Mallophaga, p. 155) as collected from the coot, *Fulica americana*.

Læmabothrium giganteum Nitzsch.

(1762) *Pediculus ciirci* Geoffry, Hist. des Ins., Vol. II, p. 598, Pl. XX, fig. 1.
(1763) *Pedieulus marinus* Scopoli, Ent. Carn., pp. 382, 1036.
(1781) *Pediculus buteoni* Fabricius; *Ricinus vulturis* Latreille.
(1818) *Læmabothrium gigantium* Nitzsch, Germar's Mag., Vol. III, p. 301.
Læmobothrium gigantium Burmeister, Vol. II, 441; Denny, p. 240; Giebel, p. 250; Piaget, Les Pédic., p. 531.

A specimen of this large species is in my collection, kindly sent to me by Mr. William Beutenmueller. It was marked from harpy eagle.

Læmobothrium hastipes Nitzsch.

Frisch, Vol. XI, fig. 24; Redi, Tab., 13.
Pediculus tinnunculus Linn., Syst. Nat., II, 1018.
Nirmus hasticeps Olfers, p. 87.
Læmobothrium hasticeps Nitzsch, Germar's Mag., Vol. III, p. 302; Burmeister, Vol. II, p. 442; Denny, p. 240; Giebel, p. 254; Piaget, p. 582.

Piaget questions the separation of this species from *giganteum*. Specimens kindly presented to me by Dr. Merriam agree well with the descriptions, and differ sufficiently from the *giganteum* in my collection so that it seems proper to indicate the form, at least.

Læmobothrium similis Kellogg.

New Mallophaga, p. 153, Pl. XIV, figs. 1 and 2.

On *Colymbus nigricollis californicus*, Lawrence, Kans. (Kellogg).

Trinoton luridum Nitzsch.

Figured (?) Redi. Pl. X (vide Piaget); Albin., Aran., pl. 48.

Trinoton luridum Nitzsch. Germar's Mag. Vol. III, p. 300; Stephen's Cat., Vol. II, p. 334; Burmeister, Handbuch. Vol II p. 441; Denny, p. 234, Pl. XXII, fig. 2; Giebel, p. 258, Pl. XVIII, fig. 7.

(?) *Trinoton gracile* Grube. Middendorff's Reise, p. 494.

(?) *Trinoton conspurcatum* Gurlt. Vol. VIII, p. 438; Pl. IV, fig. 15; Pl. II, fig. 6.

Trinoton luridum Piaget, p. 591 Pl. XLIV, fig. 3; Osborn, Bull. 7, Div. Ent., Dept. Agr.

This is a very common species on various kinds of ducks. I have met with it a number of times myself, and have noted it in collections of the National Museum, the Cassino collection, from the *Mergus serrator*, Bruner collection, Kellogg collection, etc.

Kellogg records it from *Spatula clypeata*, *Merganser serrator*, *Anas carolinensis*, *Dafila acuta*, *Anas boschas*, and *Anas americana* (Lawrence, Kans.), and *Erismatura rubida* (Monterey, Cal.).

Trinoton lituratum Nitzsch.

Germar's Mag., Ent. 1818, Vol. III, p. 300; Burmeister Handbuch, Vol. II, p. 441; Giebel, Insecta Epiz., 1874, p. 259; Piaget, Les Pédic., 1880, p. 597; Osborn, Bull. 7, Div. Ent., Dept. Agr., p. 52.

Trinoton squalidum Denny, Monog. Anop. Brit., 1842, p. 235, Pl. XXII, fig. 3; Giebel, Insecta Epiz., 1874, p. 259.

A specimen in the Cassino collection referred to this species is credited to the blue-winged teal. It has generally been credited to the goose. Kellogg records it from *Dafila acuta* and *Merganser serrator*, Lawrence, Kans.

Trinoton minor, n. sp.

Light brown, with fuscous markings, much smaller than other members of the genus. Head subtriangular, with obtuse clypeus and temporal lobes rounded in front; antennal pits covered by rounded swelling; eyes divided, prominent; head below the eyes heavily fringed with short hairs; temporal lobes with four long bristles, a blackish patch in front of the orbital swelling, and a reddish-brown patch just within and behind the eyes; occiput with a blackish margin and two diffuse brownish bands running forward to join the blackish patches in front; prothorax with lateral angles produced anteriorly, narrowed behind, a fuscous submarginal band laterally; mesothorax short, with an angular process in front; metathorax longer, margin curved; legs robust; coxæ large; tarsal pallettes fully developed; first and third pairs of legs wanting in specimen; abdomen rather narrow, tapering posteriorly; lateral angles set with long bristles; eighth segment set at posterior margin with two bristles at each side, which are longer and stronger than the others.

Length, 2.67 mm.; head, 0.59 mm.; thorax, 0.94 mm.; abdomen, 1.14 mm. Width, 0.84 mm.; abdomen, 0.87 mm.

Described from a single specimen in the Burnett collection, No. 102. "Butter-bill coot," (*Oidemia*).

Physostomum frenatum Nitzsch.

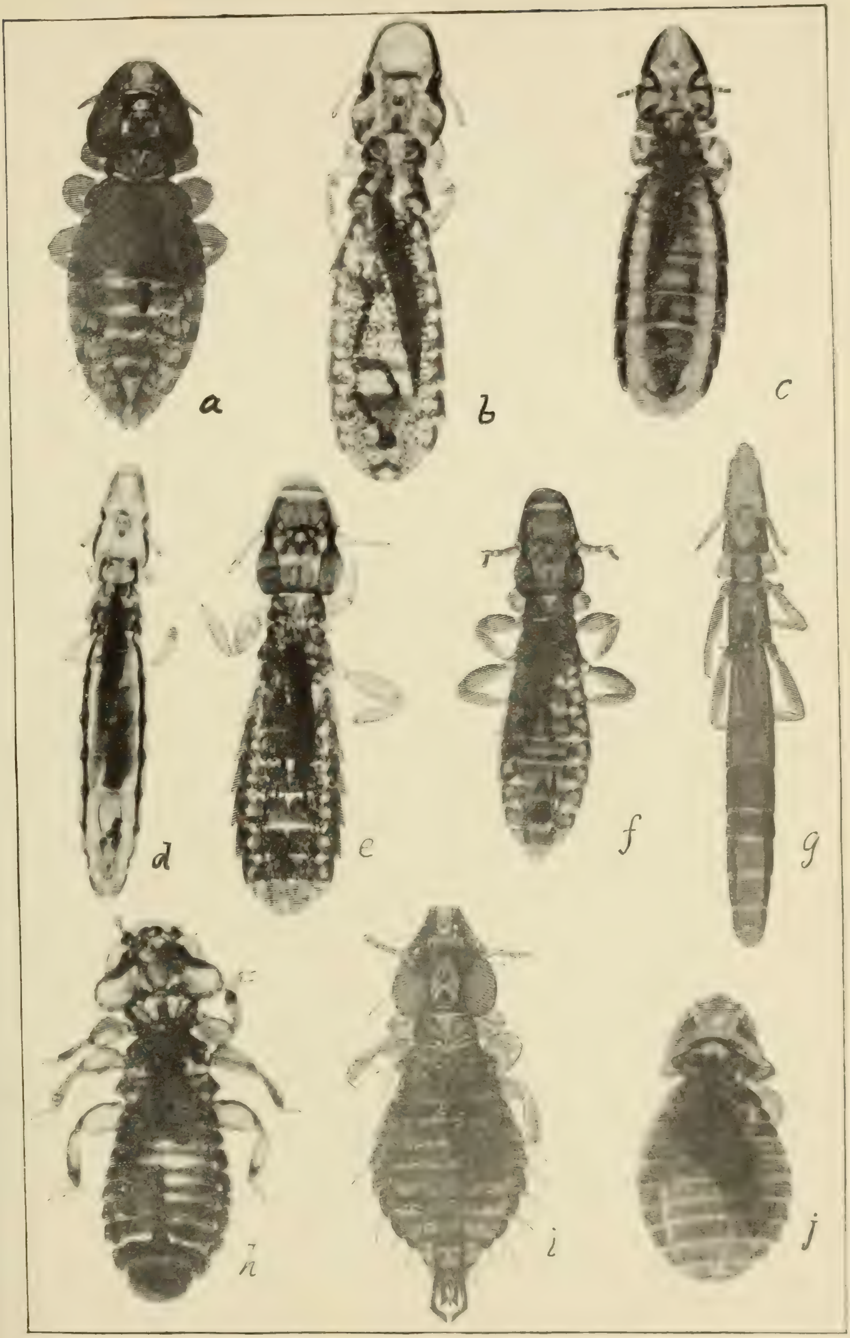
Burmeister, Handbuch, Vol. II, p. 442; Giebel, p. 256, Pl. XVIII, fig. 6; Piaget, p. 606.

From golden-crowned kinglet, Laurent collection. Very similar forms from *Passerella iliaca*, Cassino collection, and *Pipilo erytrophthalmus*, from Dr. Merriam.

Physotomum lineatum n. sp.

Light brown unicolorous, except for brown line parallel to sides of thorax and abdomen. Small for the genus.

Head subconic, sides very slightly concave, front rounded with a few very short



SPECIES OF MALLOPHAGA.

Figure *a*, *Nirmus cordatus* n. sp.; *b*, *Nirmus marginatus* n. sp.; *c*, *Nirmus abruptus* n. sp.; *d*, *Nirmus parallelus* n. sp.; *e* female, *f* male, *Lipeurus infuscatus* n. sp.; *g*, *Lipeurus subangusticeps* Denny; *h*, *Menopon interruptus* n. sp.; *i*, *Docophorus testudinarius* Denny; *j*, *Menopon expansum* n. sp. (From photographs by the author.)

hairs, pallettes small, beneath with a central elevated ridge; posterior edge above sinuous, distinctly concave each side of occiput, lateral angles produced; prothorax widening a little behind, posterior margin concave.

Legs rather long, hind ones reaching nearly to end of abdomen; abdomen of usual form for genus, sides slightly arcuate but nearly parallel, of the same color as head and thorax. A very narrow brown line parallel to sides of thorax and abdomen (in line of spiracles).

Described from three specimens from the ruby-throated humming bird (*Trochilus colubris* Linn.) in Cornell University collection, kindly loaned by Prof. J. H. Comstock.

It is quite different from any other species of the genus known to me in the uniform color.

Gyropus ovalis Nitzsch.

Gyropus ovalis Nitzsch, Germar's Mag., Vol. III, p. 304; Burmeister, Handbuch, Vol. II, p. 443; Denny, p. 245, Pl. XXIV, fig. 1; Giebel, Epiz.; Piaget, p. 609, Pl. L, fig. 5; Osborn, Bull. 7, Div. Ent., Dept. Agr.

Specimens received from Dr. A. Hassall, of Baltimore. Evidently a common parasite of the Guinea pig, its only host.

Gyropus gracilis Nitzsch.

Pediculus porcelli Schrank, Ins. Aust., p. 500, Pl. I, fig. 1.

Gyropus gracilis Nitzsch, Germar's Mag., Vol. III, p. 304; Burmeister, Vol. II, p. 443; Denny, p. 246, Pl. XXIV, fig. 2; Piaget, p. 611, Pl. L, fig. 6; Osborn, Bull. 7, Div. Ent., Dept. Agr.

Common, along with preceding, upon the Guinea pig. Numerous specimens collected by Dr. Hassall, Baltimore, Md.

CHAPTER VI.

ARACHNIDA.

While in the more restricted sense the animals of this division are not insects, they are commonly looked upon in that light, and since many of the parasitic forms have habits similar to those of the true insects, and can in many instances be treated by very similar or identical measures, often at the same time, there is the best of reason for including a discussion of them in a work having the scope of this paper.

While the group as a whole includes the spiders, scorpions, harvest men, etc., the parasitic forms are included in the order Acarina, and it will be unnecessary to enlarge on what has been said in the introductory chapter relative to the characteristics of the group as a whole, but confine what is said to the order Acarina.

Order ACARINA.

These are commonly known as mites, ticks, scab insects, mange insects, etc., and are in general distinguished by having no prominent separation between the different regions of the body, the head, thorax, and abdomen, forming one closely connected structure. They have eight legs, except in the early stages, when there are but six; the eyes are often small or obsolete, the spiracles reduced to one pair, sometimes apparently wanting; the mouth parts are fitted for piercing, biting, or in some cases for combined biting and suction, there being usually a pair of slender, sharp mandibles capable of penetrating the skin of the host animals. Much variation of habit exists, and ranges from free forms to strictly parasitic forms.

HARVEST MITES; CHIGGERS.

In the family Trombidiidæ, which includes normally plant-feeding species, we find a few species which have adopted a phase of parasitism which, though apparently abnormal, results in extreme annoyance to the animals affected.

Apparently the most abundant species in this country is the *Leptus irritans* of Riley, which is illustrated herewith. This occurs in a large portion of the United States and occasions during the summer months an enormous amount of suffering. It ranges north in the Mississippi Valley into central Iowa, at least, appearing there by the latter part of

June or fore part of July, but becoming especially annoying during August. In the latitude of Washington it is very abundant early in June, and farther south its season extends till, in southern Mexico, what is apparently the same species is abundant and equally annoying in January.

The form in which this pest is observed is invariably the larval or six-legged form. It is nearly circular in outline, the legs extending well beyond the margins of the body, of a bright red color, and so minute that it is only with the closest scrutiny that it can be detected.

It is brushed from the leaves of various plants on to the hands or clothing of people and to the bodies of other animals, and the mite then proceeds to burrow into the skin, notwithstanding the fact that, so far as all evidence shows, this proceeding is absolutely fatal to it and prevents any possibility of its maturing or producing eggs.

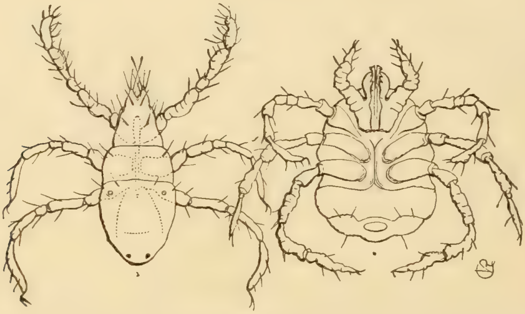


FIG. 151.—*Leptus irritans* to the right and *americana* to the left (from Riley).

Just what form this creature develops into if unmolested and allowed to pursue the even tenor of its way upon a vegetarian diet seems never to have been determined. It is assumed, however, that it changes into one of the species of Trombidium.

A related form, *L. americana*, is figured also by Riley.

In Europe a similar pest, known as *Leptus autumnalis*, is said to be a great annoyance to man and domestic animals, especially dogs and chickens.

REMEDIES.

There is great difference in the susceptibility shown by different persons to the attacks of this mite, some not seeming to be affected seriously by them, while others must submit to extreme torture every time they happen to become attacked by them, even if but few in number.

As the mites are invariably secured by working among raspberries, currants, or other shrubbery which harbors them, or by walking in grass or low herbage where they occur, sometimes even by sitting or lying for a short time upon grass or clover, it is evident that the best precaution for susceptible persons is to avoid all such exposure. Where such avoidance is impracticable, the clothing may be made to fit closely at the wrists and ankles, and then as soon as possible after having been exposed to the mites make an entire change of clothing, bathe in hot water, and if any indications of mites are present wash the affected parts with diluted carbolic acid, one part acid to 50 or 100 parts water.

In the Tropics rum or whisky is recommended as a wash, and diluted alcohol can be used with good results.

With a little pains it is possible to locate the mites, as they may be found before they have completely buried themselves in the skin in the center of the little red swelling that has been raised by their preliminary irritation, and if they are removed at this stage instead of being allowed to bury themselves in the skin the subsequent inflammation and itching will be largely prevented.

Family GAMASIDÆ.

The family Gamasidæ contains a large number of small mites, most of them being free, or semiparasitic in habit.

A large number occur as parasites on various species of insects, but the two species to be mentioned here occur on birds and are sometimes very troublesome.

THE BIRD TICK.

(*Dermanyssus avium* Dug.)

This is a very familiar form to keepers of cage birds, and is known in many places as the red mite. It occurs on a great variety of birds, and has sometimes been considered to embrace the chicken tick, mention of which follows, but that is now generally conceded to represent a distinct form. The mites are easily seen with the naked eye and appear as animated red specks running over the bodies of birds, or on the perches, bars of cages, etc. The eggs are laid in cracks or corners of the cage, where may be found also the molted skins and often numerous young and old mites.

The attacks on the birds are made, probably, for the most part at night, but the mites are usually well filled with blood, which gives them their red color.

The use of perches that are solid, smooth, and free from cracks, and the frequent dipping of these in hot water, and the thorough cleansing of the entire cage, using boiling water if there are inaccessible cracks, will serve to destroy the pests.

THE POULTRY TICK.

(*Dermanyssus gallinæ* DeGeer.)

One of the most persistent and injurious of the pests of the hennery is the little chicken mite, which gathers on the fowls, especially at night, and sucks their blood. It is a well-known form, and has been described for many years, though in many works it is confused with the preceding species or considered simply a variety of that form. Its distribution seems to extend pretty generally over the world where domestic fowls are kept.

The full-grown mites are about 1 mm. long, of a light gray or whitish color, with dark patches showing through the skin, but when full fed have a distinct red color. They swarm in cracks and corners of the henhouse, and often, when numerous, over all surrounding objects, and at such times are liable to become a great pest to man and such other animals as they may get access to.

It is possible that the presence of filth may favor their increase, as it would seem possible for them to use fluid matter as food aside from the blood of their ordinary hosts. A writer in the Poultry World, evidently a practical poultry keeper, says:

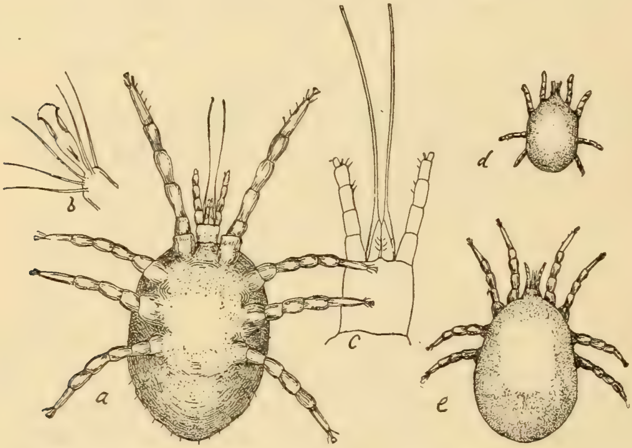
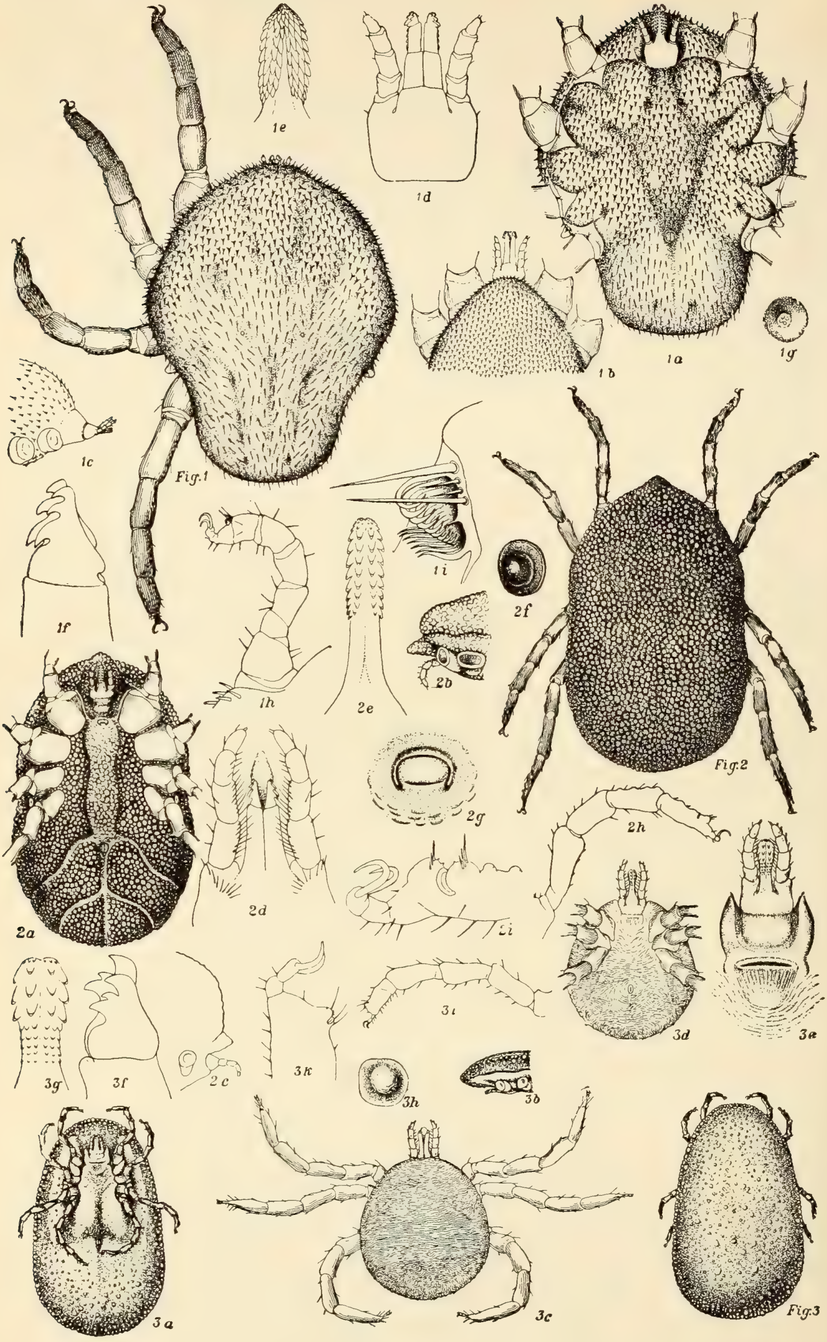


FIG. 152.—*Dermanyssus gallinæ:* *a*, adult; *b*, tarsus; *c*, mouth-parts; *d* and *e*, young—all enlarged (original).

> The mites will breed in the droppings. Rotten nest eggs are good sources. They swarm in myriads where an egg has been broken in the nest. The heat from the body of the hen on the nest hatches them by the millions. Every crack and crevice contains them. They come out on the roost at night, like bed-bugs, and prey on the birds.

The dust bath is considered of use in checking this pest, but where there is a general infestation, I believe the best plan will be found to clear the house, then spray well with kerosene or kerosene emulsion, taking pains to reach the cracks; thoroughly drench the roosts with hot water or kerosene, benzine, or gasoline, whitewash the house, or dust with carbolated lime, and then daub the ends of the roosts, where they come in contact with supports, with coal tar, so the mites will have to cross it to reach the fowls.


1e
1d
1a
1b
1g
1c
Fig. 1
1f
1i
2f
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1h
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Fig. 2
2g
2a
2d
2h
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3d
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3f
2c
3k
3i
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3b
3a
3c
Fig. 3

ARGASINÆ.

FIG. 1.—*Rynchoprium spinosum*, dorsal view ; 1*a*, ventral view ; 1*b*-1*i*, details of same.
FIG. 2.—*Ornithodorus americanus*, dorsal view ; 2*a*, ventral view ; 2*b*-2*i* details of same.
FIG. 3.—*Argas americanus*, dorsal view ; 3*a*, ventral view ; 3*b*, side view of ventral portion ; 3*c*, larva, dorsal view ; 3*d*, larva, ventral view ; 3*e*-3*k*, details of same—all highly magnified (from Marx).

Family IXODIDÆ.

This family includes the ticks proper, and the species are some of them large, and especially when gorged with blood, and the females with eggs are quite bulky. In some cases they reach a length of nearly half an inch. The common dog ticks will serve as a good illustration of the group.

They are only semiparasitic, most species attaining some growth before attaching themselves to animals, and in many cases they move to and from their hosts at will.

The species of Argas, formerly included with the Gamasids, are now included in this group as a subfamily.

EXPLANATION OF PLATE III.

Fig. 1. Rhynchoprium spinosum, dorsal view.
1*a*. Ventral view.
1*b*. Young, capitulum not redrawn.
1*c*. Full sucked individual, capitulum projected.
1*d*. Capitulum, dorsal view.
1*e*. Maxillæ.
1*f*. Mandibles.
1*g*. Stigma.
1*h*. Front foot.
1*i*. Haller's organ of hearing.
Fig. 2. Ornithodorus americanus, dorsal view.
2*a*. Ventral view.
2*b*. Side view of anterior portion.
2*c*. Position of capitulum in full-sucked individual.
Fig. 2*d*. Capitulum, dorsal view.
2*e*. Maxillæ.
2*f*. Stigma.
2*g*. Female sexual orifice.
2*h*. Front foot.
2*i*. Haller's organ of hearing.
Fig. 3. Argas americanus, dorsal view.
3*a*. Ventral view.
3*b*. Side view of anterior portion.
3*c*. Larva, dorsal view.
3*d*. Larva, ventral view.
3*e*. Capitulum, ventral view.
3*f*. Mandibles.
3*g*. Maxillæ.
3*h*. Stigma.
3*i*. Front foot.
3*k*. Haller's organ.

THE EAR MITE.

(*Sejus auris* Leidy.)

In 1872 Dr. Leidy, in the Proceedings of the Philadelphia Academy, described a mite from the ear of an ox, which he referred to the genus Gamasus, but Murray considers it a Sejus. It is evidently not a common form, as I find no further mention of it in American literature and nothing to indicate an injurious attack from it.

THE PIGEON TICK.

(*Argas reflexus* Fab.)

This is a common species in both the Old and New World, and occurs principally in the more southern latitudes, but in Europe extends north into Germany and England. In the United States it is common, I believe, as far north as St. Louis.

It is found mainly in pigeon houses and sucks blood for nourishment, but it is capable of living an almost incredible length of time without food, instances being on record where it has been kept in confinement without food for two years, during which time the molts recur at frequent intervals.

The body is projected in front far in advance of the head, the color is a deep gray, the form ovate, and the length about one-eighth of an inch.

A related species, *Argas persicus*, is said to be a pest in houses in Persia, and *Argas moubata* in Angola, and *Argas talaje* in Guatemala, are equally annoying in their respective habitats.

THE AMERICAN ARGAS.

(*Argas americanus* Pack.)

This species was described by Packard in the Report of the Geological Survey of the Territories for 1872 (p. 740), but rather oddly both Murray and Railliet credit it to Riley. Railliet, however, cites Hope as authority for its reference to *radiatus*.

It is reported by Dr. Francis as destructive to chickens in parts of Texas, and in the original description it is said to have been collected with the cattle tick from cattle.

Packard's description reads:

> Body very flat and thin, oval, with the head and mouth parts concealed by the overreaching dorsal portion of the body, which is bent upward around the margin, though the edge is not revolute. Body above covered with very numerous little round pits, large in the middle and becoming smaller on the edge. There are two large, conspicuous pits on the middle of the anterior third of the body, just in front of the middle transverse curved row of six smaller pits, three on each side. Behind are six prominent pits, three on each side. On posterior third of the body are rows of these punctures radiating outward. The edge of the body is roughly granulated. Margin of the body beneath pitted as above. Smooth between the legs and on the head. Palpi long and slender when stretched out, not reaching the edge of the body. Legs large and stout, hind pair just reaching edge of body. Claws long and curved, as usual.
>
> Length, 0.26 inch; breadth, 0.15 inch.

Shown in Pl. III, fig. 3, drawn by Dr. Marx, the figure, however, not indicating the radiation of the pits on the posterior part of dorsal surface described and figured by Packard, and which gives the name *radiatus*.

Two related species, the *Rhynchoprium spinosum* Marx, from Texas, and the *Ornithodorus americanus* are illustrated in Pl. III by the lamented Dr. George Marx.

THE CATTLE TICK.

(*Boophilus bovis* Riley.)[1]

This is without question the most important of the American species of ticks and has a double importance since it has been determined that it serves as a carrier of the destructive Texas fever of cattle.

It was described in 1869 by Prof. C. V. Riley[2] and figures extensively in discussions of cattle pests since. Dr. Cooper Curtice holds that the Algerian tick, described by Mégnin as *Ixodes dugesii*, is identical with the American form, with the probability that it was introduced into America on imported cattle.

The elaborate report on this species by Dr. Curtice[3] will serve as a basis for a summary of the essential facts regarding the species, while the numerous experiments of Dr. M. Francis,[3] of the Texas Experiment Station, furnish the most valuable guide in treatment.

The species is distributed certainly through all of the warmer portions of the United States and quite certainly in Mexico, Central America, South America, and Cuba, while, if the species occurring in northern Africa is identical, it would extend its range through Egypt, Algeria, and probably all northern Africa and some of the southernmost parts of Europe.

Professor Riley's original description and remarks are as follows:

> A reddish, coriaceous, flattened species, with the body oblong-oval, contracted just behind the middle, and with two longitudinal impressions above this contraction and three below it, more especially visible in the dried specimen. Head short and broad, not spined behind, with two deep, round pits. Palpi and beak together unusually short, the palpi being slender. Labium short and broad, densely spined beneath. Mandibles smooth above, with terminal hooks. Thoracic shield distinct, one-third longer than wide, smooth and polished; convex, with the lyrate medial convexity very distinct. Legs long and slender, pale testaceous red; coxæ not spined.
>
> Length of body, 0.15 of an inch; width, 0.09 of an inch.
>
> Missouri collection, C. V. Riley.

"This is the cattle tick of the Western States. Several hundred specimens in different stages of growth have also been received from Pulvon, west coast of Nicaragua, taken from the horned cattle, and on a species of Dasyprocta by Mr. J. McNeil. They preserve the elongated flattened form, with the body contracted behind the middle, by which this species may be easily identified. The largest specimens measure

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[1] If Curtice is correct in connecting this with the African form and Railliet in referring it to *Rhipicéphalus sanguineus* Latr., the synonomy becomes quite complicated, especially if Curtice's suspicion that the *rosea* of Koch and the *annulatus* of Say also come here. The whole synonomy would run something as follows: *Ixodes sanguineus* Latr. (1806); *Ixodes annulatus* Say (1820); *Ixodes plumbeus* Dugès (1834); *Ixodes dugesii* Gervais (1844); *Hæmaphysalis rosea* Koch (1844); *Rhipicephalus sanguineus* and *siculas* Koch (1847); *Ixodes bovis* Riley (1869); *Ixodes dugesii* Mégnin (1880); *Boophilus bovis* Curtice (1890); *Rhipicephalus sanguineus* Railliet (1895).

[2] Government Report upon the Diseases of Cattle by Gamgee (1869).

[3] Bulletin 24, Texas Experiment Station.

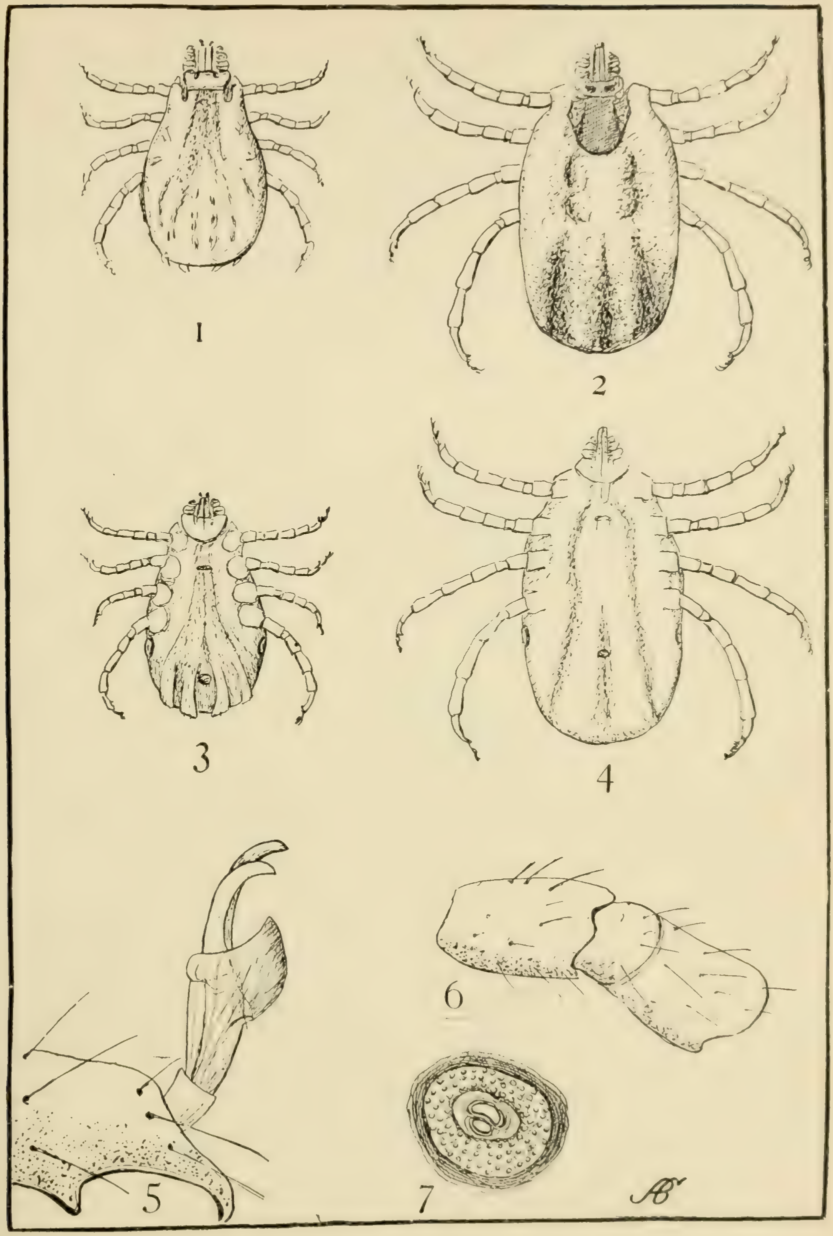
0.50 by 0.30 of an inch. When gorged with blood they are nearly as thick through as they are broad. In the freshly hatched hexapodous young, and the young in the next stage of growth, the thoracic shield is one-third the size of the whole body, which is pale yellowish, with very distinct crenulations on the hinder edge. The fourth pair of legs are added apparently at the first molt. It is called 'gar apata' by the inhabitants of Nicaragua."

Curtice gives the life history in considerable detail, and the following extracts will show the essential points:

> On October 10 I placed some of these eggs (Pl. V, fig. 5) in a small, glass-covered dish filled with damp mold and set it aside in the incubating room of the laboratory. On November 4 the young ticks (Pl, V, fig. 6) had begun to emerge, and by November 15 the hatching was completed, each egg having produced a young tick.
>
> At this time the ticks were taken to the bureau experimental farm and put on a calf which was confined in a stable, whose temperature was maintained at summer heat throughout the experiment. A calf with a white abdomen was selected, thrown on its back, sprinkled with ticks directly on its fine, silky hairs, and time allowed for them to crawl into the skin. In this proceeding the certainty of the young ticks arriving at the most suitable surroundings was assured.
>
> It is well to state here that the parents of these young ticks were the last seen at the station on any of the cattle, and that the room of experiment and the calf were quite free from ticks before the experiment began. The following table will serve to illustrate the sequence of events in the experiment and present it in rough but compact form:

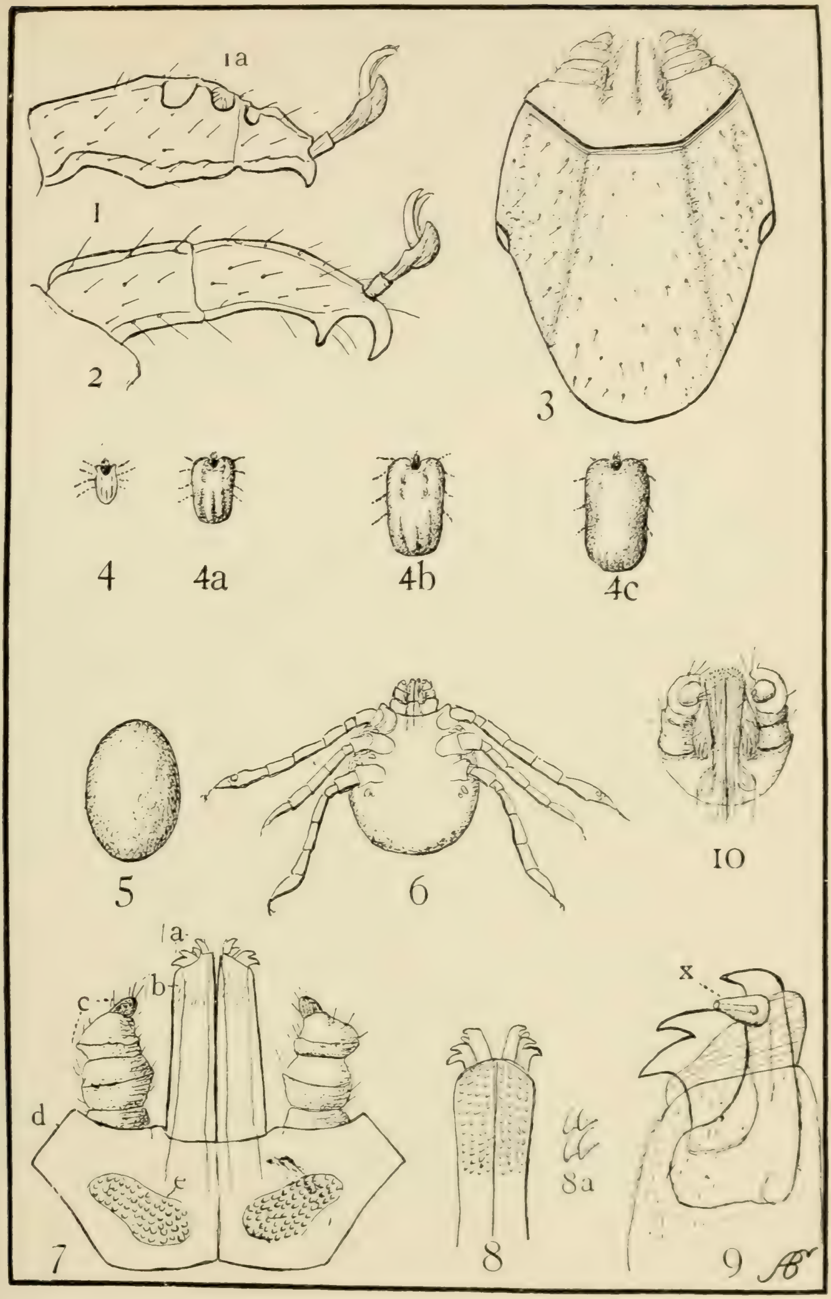
Date.	Stage of experiment.	Time consumed in various stages.
Oct. 3	Egg laying begun	
Oct. 10	Egg laying finished	Ovipositing 1 week.
Nov. 4	Ticks appeared	Hatching 3 and 4 weeks.
Nov. 15	Rearing begun	Unnecessary interval of 1 week.
Nov. 22	First molt, larva to nymph	Larval stage lasted 1 week.
Nov. 29	Second molt, nymph to adult	Lasted 1 week.
Dec. 11	Female half grown with male	About 2 weeks later.
Dec. 16	Experiment closed	About 1 week.
	Experiment endured	About 2½ months.

> The eggs were laid in a little mass, were subovoid, dark brown and opaque, and coated with some protective substance. In alcohol they show a thin, shell-like covering, with a dark, opaque mass within. In the latter stages of incubation the form of the young ticks became more and more apparent until they emerged. The exit from the shell seemed to be by the shell rupturing and the imprisoned occupant thrusting it off with its feet. The torn edges afterwards rolled inward and produced the appearance of clam shells, so frequently mentioned in writings on this subject.
>
> The larva is six-footed, possesses no sexual organs, and wants the large, single stigmata found in later stages.
>
> The next or nymphal stage, as seen through the skin of the larva, has added a pair of limbs behind the others and a pair of large stigmata behind them. The additional legs lie along the sides in a loop with its convexity directed caudally. The contents of the three front pairs of legs have withdrawn until only their white tips remain in the testa about to be molted.
>
> The difference between the ticks destined to become either male or female during their final molt is not marked. The average of the males is smaller, but a small female may not be any larger than an ordinary male. In each the mouth ring and mouth parts, the shield-like headpiece, the breathing pores, the limbs, and the body are alike.
>
> After they emerge, however, the males (Pl. IV, figs. 1 to 3) can be quickly chosen



THE CATTLE TICK (*Boophilus bovis* Riley.)

1, Male, seen from above; 2, Female, seen from above; 3, Male, seen from below; 4, Female, seen from below; 5, Claw and pulvillus; 6, Lower surface of first, second, and third segment of leg; 7, Spiracle or peritreme. (From Curtice, Bul. 24, Tex. Ag. Ex. Sta.)



THE CATTLE TICK (*Boophilus bovis* Riley.)

1, Front foot, showing single spur; 1a, Supposed sense organs; 2, Hind foot, showing double spur; 3, Head of female; 4, 4a, 4b, 4c, Female ticks, natural size, shown at different stages of feeding; 5, Egg; 6, Young tick; 7, Dorsal surface of the mouth parts of female—a, mandible, b, labrum, c, palpus, d, mouth ring, e, spots covered with papillæ; 8, Labium and mandibles; 8a, Papillæ enlarged; 9, Mandible-X-Busk's organ, use unknown; 10, Mouth parts of young tick. (From Curtice, Bul. 24. Tex. Ag. Ex. Sta.)

by their smaller size, by the absence of a well-defined head shield, by the extension of the shield over the whole back, and by the two pairs of chitinous plates situated on the abdomen behind and on each side of the anus.

Throughout life the male enlarges but little. He becomes a little broader, longer, and thicker, but not markedly so. The female, on the contrary, grows to a comparatively immense size (Pl. V, figs. 4, *4a*, *4b*, *4c*), swelling day by day, her body becoming so rotund and replete with the food drawn from her host that she can scarcely be recognized as of the same species as the males. While her body has inflated, however, her head, her legs, and breathing pores have not undergone any changes. These remain exactly of the same size as in the beginning, and, with the exception of the head shield, are but little different from those of the male. The disparity in size between the legs and the body of the fully-gorged female is so marked that the legs and head appear even smaller than at first. The comparatively small size of the male has caused it to be overlooked or, if found, caused it to be classed among the young of this species.

After molting, the young female again attaches herself to her host and seems rarely to change her position. While she may be able to do so at first with ease, she becomes so heavy and logy later on that any change would cause her to fall to the ground should she loosen her hold with her beak. The males, however, remain small and light, and it is not impossible for them to change their position, and no doubt do so. After molting, they hunt for mates through the dense growth of cattle hairs and, finding them, attach to their host so that they can conveniently embrace them belly to belly and bring their external genitals in apposition.

When fully gorged, when the organs of generation are fully prepared, and either the eggs within fertilized or a sufficient quantity of semen stored in the receptacle for their fertilization, the female (Pl. IV, fig. *4b*) loosens her hold on her host and falls to the ground. She must do this to lay her eggs. Crawling off to some dark corner, her work soon begins. Any delay seems to me to be caused by the tick not being prepared to undergo the final act at the time of removal from the cow. The female may, if detached, lay eggs any time after it is half grown. (Pl. V, fig. *4c*.) Most ticks under my observation have waited a day or two before commencing ovipositing, and some e.en mcre. While the tick prefers to act in quiet, she will, if retarded long enough, show her secret method under almost any difficulties.

I must now draw attention to an organ which, though accessory, plays an important rôle in ovipositing. Between the mouth ring and the head shield is a space which becomes very marked in the fecund tick. At this point open glands, which are paired, racemose, and situated just under and within the head shield. During the last days of the growth of the ticks these glands become distended with a viscous fluid substance with which the eggs are to be coated for protection.

The first visible act in ovipositing is the withdrawal of the mouth ring and appendages apparently into the body, thereby leaving a depression or pocket. At the same time the ovipositor protrudes toward the bulging skin at the back of the mouth ring until they touch. The head is now entirely concealed. As soon as the ovipositor touches the opposing organ at the slit which appears in its middle, an egg passes from it and is immediately surrounded by the coating sac. This passage of the egg is difficult to detect, but if the passage is interfered with can be made out after a time. The ovipositor then withdraws, the mouth parts appear, and the egg is pushed from its coating sac, which recedes from around it. As the mouth parts are commonly known as the head, it appears as though the female passed the eggs over her head and laid them from her neck. A curious affair, surely.

The object of coating the egg has been clearly demonstrated by Bertkau, who found that eggs laid after destroying the coating sac and preventing the eggs being covered dried up and would not hatch, while others newly laid by the same female and coated hatched in due time. Egg after egg does the little creature lay, her pile growing constantly larger, while her body constantly contracts, until in about a week little is left but a yellowish, dried-up, shriveled skin, whence all life has departed.

RELATION OF TICKS TO TEXAS FEVER.

That ticks have a relation to Texas fever was held many years ago by people acquainted with Southern cattle, but no valid reason for such belief could be adduced, and the idea was looked upon by the scientific world as only one of the popular notions that come from taking coincidences as meaning cause and effect.

When, however, the study of the disease was entered upon from the standpoint of modern bacteriology, it was learned that the ticks may have a most important relationship as carriers of the disease germ and thereby serve as agents of infection. It is now generally accepted that even if the ticks are not an essential means of transmission, they are so generally the source of infection that their destruction constitutes a most important factor in the prevention of the disease.

PREVENTION AND REMEDY.

Since the ticks get access to the animals mainly by being brushed upon them from the leaves of bushy plants or trees, the keeping of cattle away from wooded pastures is recommended as one advantageous method of preventing their injuries. Weed strongly recommends the feeding of sulphur and salt as a preventive.

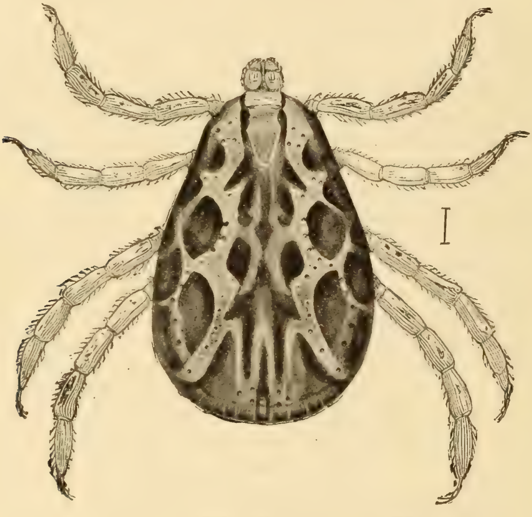


FIG. 153.—*Dermacentor americanus;* male—enlarged (original).

For direct treatment there is probably nothing that equals the dipping process, by which the whole animal is completely drenched with a dipping solution. Dr. Francis, after using a spraying outfit for the purpose, says that he has discarded it entirely for the more satisfactory method of dipping, special preference being given to a dip of cottonseed oil. Full details of this process and the form of vat required are given in the chapter on remedies and their application.

THE DOG TICK OR WOOD TICK.

(*Dermacentor americanus* Linn.)

The most common tick through the Northern States, at least, is the so-called dog tick, the name being associated with its most common host. It occurs, however, very frequently on other animals and on man. When fully gorged, the ticks are nearly half an inch long, and they seem to favor the ears of dogs, or at least parts near the head.

The males, fig. 153, do not enlarge like the females, but are about the size of the females before engorgement, and the body above as well as the borders of the legs are marked with bright, silvery lines and blotches, as shown in the figure.

As with other species, the young climb to the outer parts of leaves, from whence they are readily brushed to the bodies of passing animals.

THE LONE STAR TICK.

(*Amblyomma unipuncta* Pack.)

This species, next to the cattle tick, is probably of the most importance in the Southern States, sharing with that species the hospitality of cattle and also attacking other domestic animals. It is thought probable that, like *bovis*, it may convey Texas fever.

It is easily known by the single bright, silvery spot on the back. When fully gorged, the female is about equal to the cattle tick in size.

Measures of treatment will be the same as for that species.

THE RABBIT TICK.

(*Rhiphistoma leporis.*)

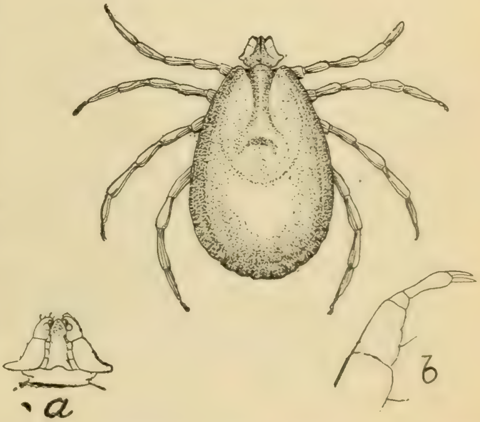


FIG. 154.—*Rhiphistoma leporis*: *a*, ventral view of mouth parts; *b*, tarsus—enlarged (original).

This is a rather common species on rabbits, and is found perhaps more commonly in the ear than elsewhere on the host animal. It is a small species, and the figure will indicate its form.

Ixodes ricinus Linn.

A very common tick upon the little ground squirrels in the Mississippi Valley is a species which Dr. Marx has determined for me as *ricinus*. If this be identical with the European *ricinus*, its habits would seem to be somewhat different, as there it is said to occur on dogs and other large mammals, but here it is apparently confined pretty closely to small rodents.

The figure will serve to distinguish it, and it is hoped that it may receive the attention of students, so that the full details of its habits may be better known.

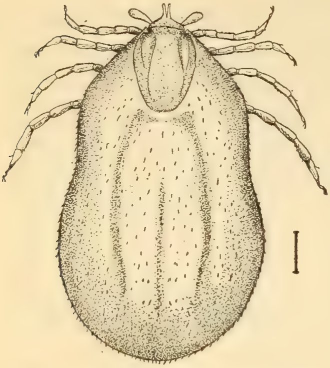


FIG. 155.—*Ixodes ricinus*—enlarged (original).

Ixodes reduvius, *erinaceus*, and *marginatus*, *Hyalomma ægyptium* and *africanum*, and *Dermacentor reticulatus* are among the species recorded as troublesome in the Old World.

Family SARCOPTIDÆ.

This family includes species which are strictly parasitic, and all may be considered as normally infesting the skin, those species which occur within the quills of feathers, in burrows of the skin, or in the subcutaneous tissue, or on internal organs, being extreme forms and doubtless in all cases derivatives from species that first lived on the surface. In fact, the extreme forms of mites in this family show in a beautiful manner the gradual adaptation to different modes of living and lead to the worm-like condition presented by Demodex.

The species are all minute, often almost invisible to the naked eye, the skin striated or furrowed, usually white or transparent, the mouth parts fitted for biting or suction, the tarsi generally with sucking disks for attachment, and the eyes wanting.

THE PIGEON PLUME MITE.

(*Falciger rostratus* Buchholz.)

These mites live in the feathers of the pigeon and other birds, and some very interesting facts have been brought to light by the studies of Megnin and Trouessart, which show that the mite may undergo a peculiar transformation during the immature stages, whereby, instead of remaining on the feathers outside the body, they migrate within the skin and live in the subcutaneous tissue or attached to the blood vessels of the neck. In this form they are rather worm-like, and were originally described as a distinct species, *Hypoderas columbæ*.

The same form occurs on the blue heron, and I have taken it in immense numbers from the subcutaneous tissue of this bird at Ames.

In the genus Dermaleichus and allies we have an immense number of forms occurring on various species of birds, scarcely any of which have been studied in this country.

They will form a most interesting study, though, so far as present knowledge indicates, there is little of economic importance to be attached to them.

THE CYSTIC FOWL MITE.

(*Laminosioptes cysticola* Vizioli.)

This mite is described as living normally on the surface of the skin or under scales, but commonly working into the subcutaneous connective tissue, more rarely to the deeper portions, and on its death the presence of the dead matter results in the formation of a calcareous cyst or miliary body, which gave rise to the technical name of the species.

Chickens, pheasants, and geese are among its hosts. I do not know of its occurrence in the United States.

INTERNAL CHICKEN MITE.

(*Cytodites nudus* Vizioli.)

These are minute mites that live in the air passages of gallinaceous birds particularly, and, according to Railliet, they appear to the naked eye like minute active granules running over the surface of the walls of the air cells and in the trachea and bronchi. They appear to suck simply the serosity of the tissues, and, unless in great number, to cause no great inconvenience to their hosts, but if in great numbers to cause active irritation and asphyxia.

The species has been observed in this country at Washington, D. C.,[1] and I have specimens from Dr. Hassall, of Baltimore, taken from the peritoneum of chicken.

MITES INFESTING MICE.

We may mention here two interesting little mites, *Myobia musculi* and *Myocoptes musculinus*, which infest mice. The former I have found many times on mice at Ames, and have also received it from Professor Bruner, of Nebraska University.

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[1] Riley Am. Nat., Vol. XVII, p. 422.

THE EAR MITE.

(*Chorioptes auricularum* Lucas et Nicolet.)

This species, represented by varieties *canis*, *felis*, *cati*, and *furonis*, is described as affecting particularly the auditory canal of its hosts. I am not aware of its recognition yet in America.

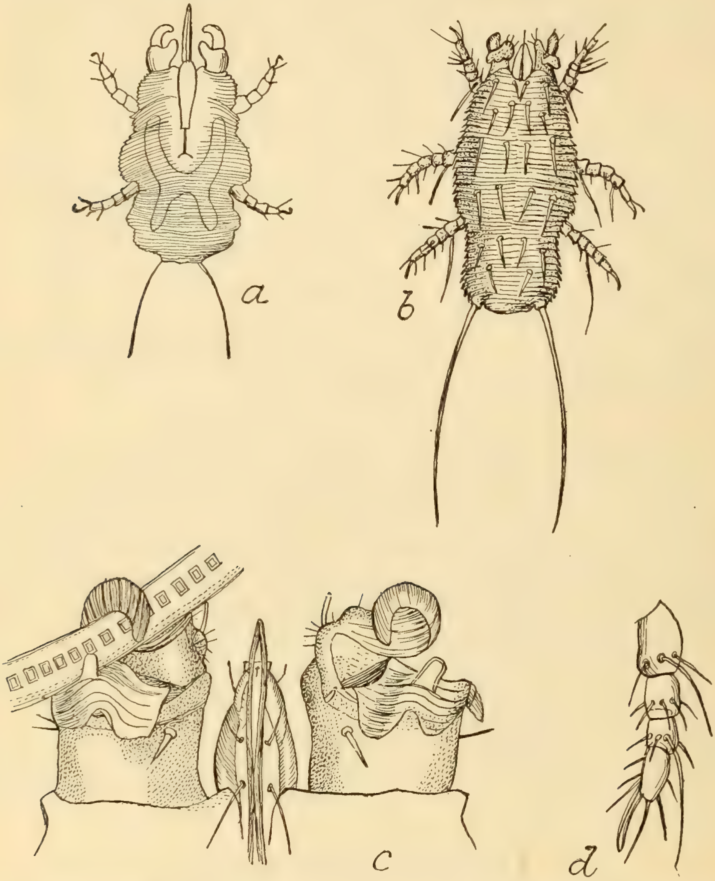

FIG. 156.—*Myobia musculi*: *a*, young; *b*, female; *c*, mouth and front legs more highly magnified; *d*, tarsus and claw of posterior leg—all magnified (copied from Murray's figures after Claparède).

THE CHORIOPTES OF THE HORSE AND OX AND GOAT.

(*Chorioptes symbiotes* Verheyen.)

This mite, unlike the itch mite, does not burrow into the skin, but adheres to the surface or to hairs by means of remarkable sucking organs attached to the legs. From this vantage ground it pierces the skin and feeds upon the serous fluids.

The varieties occurring on the horse (*equi*), on cattle (*bovis*), and on the goat (*capræ*), are considered certainly as belonging to the one species, while there is some question as to the form occurring on sheep, mentioned later, and on the rabbit.

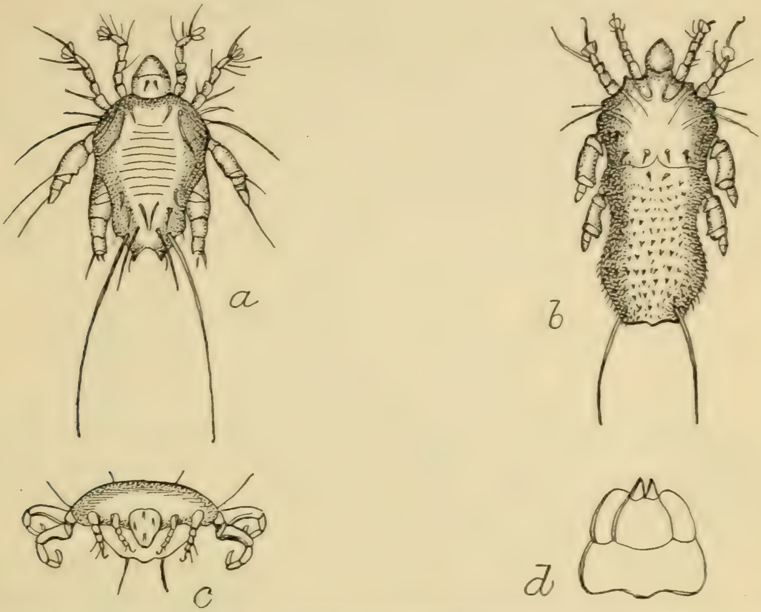

FIG. 157.—*Myocoptes musculinus:* a, male; b, female; c, front view; d, mouth (copied from Murray's figures after Claparède).

The variety occurring on goats is credited with having ravaged the goats, in the Grisons, in the valley of the Prattigau, Switzerland, in 1851, 1852, and 1853, when out of 2,500 animals half were attacked and 500 died.

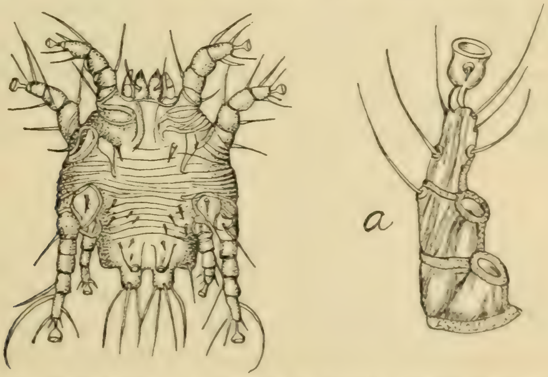

FIG. 158.—*Chorioptes symbiotes* (male): a, anterior leg, showing suckers (after Furstenberg, copied from Murray).

Evidently the dipping treatment will prove the most effective for these parasites.

Foot Scab of Sheep.

This variety of scab, which is due to *Chorioptes symbiotes* Verheyen, var. *ovis*, is of rare occurrence. It has been noticed and studied in Germany by Zurn.

The seat of the disease is in the feet and limbs. The disease progresses very slowly from the feet, and little by little invades the upper part of the limbs and adjoining parts. It is not readily communicable to other sheep, and spreads slowly.

In the beginning this variety of scab is characterized by the reddening, followed by the abundant scaling of the skin, and later by yellowish white crusts. The animals stamp, scratch, and bite the parts, showing an intense itching. As the disease progresses the crusts become thicker, cracks form in the folds of the pastern, and the limbs become quite unsightly. The parasites swarm beneath the crusts, and when found form a certain symptom of the character of the disease.

Foot scab is not a serious malady, as it readily yields to treatment and is slow of extension. Any of the remedies proposed for the treatment of common scab may be used with good effect. (Curtice.)

The Scab Mite of Sheep, Horses, and Cattle.[1]

(*Psoroptes communis* Furst.)

The disease known as scab of sheep is among the few parasitic diseases which is fully appreciated by the majority of sheep breeders, so well known, indeed, that many of the States have stringent laws in force for its quarantine or extermination. Curtice says:

> Of all the diseases of sheep in this country scab is the most feared by the flock master. So insidious is its attack, so rapid its course, so destructive its effects, and so difficult is it to exterminate that it has justly earned the distinction of being more injurious than any other disease caused by external parasites. Scab alone of the parasitic diseases has become the subject of legislation in most countries, and yet, if proper precautions were taken and a rational treatment followed, this disease could soon be completely eradicated.

The earlier writings upon the disease do not give us definite information as to the parasite in hand, but in 1841 Gervais (Ann. Soc. Nat.) gave the species a scientific description under the name of *Psoroptes equi*, and the later publications of Gerlach, Furstenberg, Murray, and Mégnin contain detailed discussions of its habits, anatomy, etc.

Scab Mite of Sheep.

(Var. *ovis*.)

This is the variety which produces the best known form of disease; indeed it appears that the effects of this parasite are by no means so much dreaded upon the other hosts, either because those animals are not so seriously influenced by its presence or because their skins do not furnish so favorable a resort for the multiplication of the pests. On this account the history of the species is more particularly the history of this variety.

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[1] There has been considerable confusion with regard to the name of this species, partly owing to the fact that some authors have given a name for each form occurring on the horse, sheep, and cow, partly because the earlier names have not been respected by later writers. The names adopted here are the ones that seem to be the rightful ones, taking the first for the species as a whole and using the varietal names to indicate the host animal.

Its distribution is at present practically over the entire world where sheep are bred, and while there may be practical immunity in some States where vigilant attention has been in practice, no sheep breeder should neglect occasional examination for it nor, especially, the most careful scrutiny of all new animals introduced into his flock.

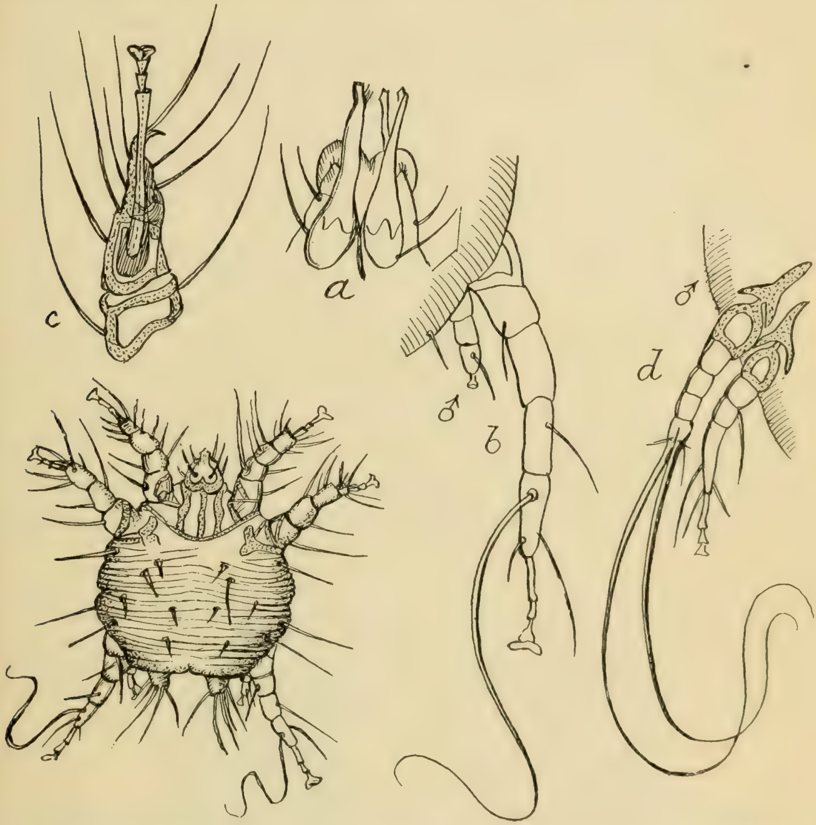

FIG. 159.—*Psoroptes communis* var. *equi*. (Copied from Murray's figure after Furstenberg.)

The effects of the parasite on the sheep and the appearances by which it may be detected are here quoted from Curtice's Animal Parasites of Sheep:

> Attention to the disease is first attracted by the infected sheep scratching and biting and rubbing themselves. The coats of the animals look rough, taggy, and felted. The itching is always most violent when the sheep have been heated by driving or warming in the stable.
>
> By separating the wool and examining a recently infected spot there can be seen some minute elevations which differ from the surrounding skin in being slightly whiter or yellower and which have been produced by the bites of the pests. The

insects themselves can be found among the hairs at but little distance from the bites. As time passes and the insects multiply in numbers these elevations become more and more numerous and closer and closer together, until they finally unite over a considerable extent. From the summit of each elevation or papule a watery, serous fluid exudes and accumulates, which transforms them into vesicles and pustules, and which in drying cover them over with a thin crust. In a few days the whole surface is covered with a yellowish, greasy, scaly layer, under which the parasites are hidden. As the disease proceeds this layer gradually increases in thickness by an increase of the serous exudate, and in circumference by the extension of inflammation produced by the ever-multiplying parasites which live beneath it, forming scaly crusts. These crusts in being torn out, mainly by the rubbing with which the sheep endeavors to allay its intense itching, carry with them the tags of the wool, the loss of which is an early symptom of the disease. At a later period the crusts are replaced by another set of thicker, firmer, adherent scabs, which are still further enlarged by the outward migration of the parasites. As they abandon the center of the scabs these are again replaced by a peeling off of the external layers of the skin, which gradually heals, while the disease slowly progresses at the outside. The complete cure is very slow, and the skin remains thick and folded for a long time. In sheared sheep the skin becomes covered by a thick, dry crust, like parchment, while beneath it remains much swollen.

The fleece of scabby sheep presents a characteristic rough look. In places the wool is stuck together in masses; in others it falls, while in others, which are apparently sound, it can be easily plucked off. The rubbing and scratching indulged in by the sheep not only tend to tear away the wool but increase the irritation of the skin, which may be intensely inflamed and finally end in superficial death of the part. Unlike Sarcoptes, the Psoroptes seeks the longest, thickest wool. It begins its attack along the back and extends to the neck, flanks, and rump. The Psoroptes are seldom found in the region of the chest and abdomen. They are collected in masses on circumscribed surfaces. The scabs they produce constantly increase at their edges, and their number depends on the number of places invaded. Owing to the closeness in which the sheep congregate and to their violent scratching, the parasites become very generally scattered, and finally, the scabs may run together.

While few of the parasites are present in the older diseased parts, at the edges of the scabs they can be found in swarms. They look like little white points with a brownish extremity. If picked up by the point of the knife or a sharp stick and placed on the hand they will be seen to move. The six-legged young, the eight-legged adults, the sexes, couples joined together, and the eggs of this interesting insect can easily be identified by the aid of a low-power magnifying glass.

DESCRIPTION AND LIFE HISTORY.

The eggs of this mite are minute, glistening white specks, longer than broad, and nearly uniform in thickness. They may be found under the scabs as before mentioned, and their detection, even when mites are not seen, may be taken as evidence of the disease.

The larvæ have nearly the same shape as the adults, but are to be distinguished by the fact that only six legs are apparent.

The full-grown mites are nearly as broad as long, and are characterized by their piercing mouth parts and the structure of the two posterior pairs of legs (see fig. 159). In the male, the fourth is much reduced, and the third bears a long thread-like appendage passing the sucker, while in the female this leg carries two long, thread-like organs and no sucker.

The only treatment for this species worthy of recognition is that of dipping, and this, if properly done, will secure the extermination of the pest, and a flock once freed will not become again infected except by exposure to infected animals or by the introduction of scabby individuals.

So important is this parasite deemed that many of the States have adopted stringent laws for the quarantine of infected animals and for prescribing dips that must be used. A summary of these regulations and the formulæ for the various dips will be found in Curtice's Animal Parasites of Sheep, which should be in the hands of all sheep owners.

The particular kind of dip is of less importance than the thorough use of the one selected. The tobacco dips, sulphur and lime dips, and also several of the patent dips prepared by reputable firms, can be recommended. The main objection to the latter, perhaps, is the fact that the user must pay a rather exorbitant price for a few simple chemicals, and further, in the case of the arsenical dips, that he may not know the ingredients or their proportions and thereby endanger the animals treated. (See details of dipping in chapter on remedies.)

The Itch Mite.

(*Sarcoptes scabiei* Latr.)

The itch mite of man is perhaps becoming a pretty rare pest in civilized communities, but since it occurs at times on domestic animals, and in certain varieties becomes at times a serious pest to such animals, it deserves treatment here. Authors have differed greatly in their treatment of the species, some making a different species for each host animal, believing that they could find distinctive characters in the size, arrangement of spines, etc., but Railliet, who has published the latest full discussion of the species, has combined most of these under the one species *scabiei*, though in some cases retaining the varietal distinction for various hosts.

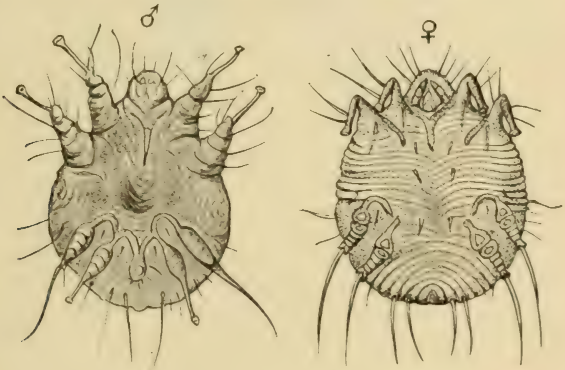

Fig. 160.—*Sarcoptes scatiei:* male and female (reduced from Furstenberg, after Murray).

The varieties so retained are *hominis*, infesting man; *scabiei crustosæ* Furst., for the so-called "Norway itch;" *equi*, for the form infesting the horse; *ovis*, on the sheep; *capræ*, on the goat; *cameli*, on the camel; *auchenicæ*, on the llama; *suis*, on the hog; *cuniculi*, for the rabbit and hare; *furonis*, on the ferret; *canis*, on the dog; *lupi*, on the wolf; *vulpis*, on the fox; *leonis*, on the lion, and *wombati*, on the wombat.

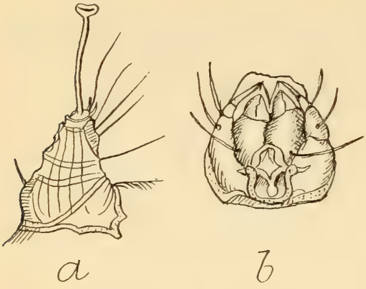

FIG. 161.—*Sarcoptes scabiei: a*, anterior leg; *b*, mouth parts (reduced from Furstenberg, after Murray).

All stages of the parasite occur on the host upon which it is absolutely dependent for existence. Generation after generation may occur on the same animal. The mite burrows into the skin, in this respect differing from the scab mites.

The adult mites are flattened, rather circular in outline, and may be separated from related forms by the character of the feet and by the presence of six short spines or thorns on the thoracic portion and fourteen on the abdominal portion of the body.

Eggs are deposited along the burrow as the mite extends its channel into the deeper portions of the skin, and as they hatch the young feed upon the surrounding tissues, and it is said molt four times before maturity. When fully grown they wander around and mate on the surface of the skin, after which the females begin a fresh burrow.

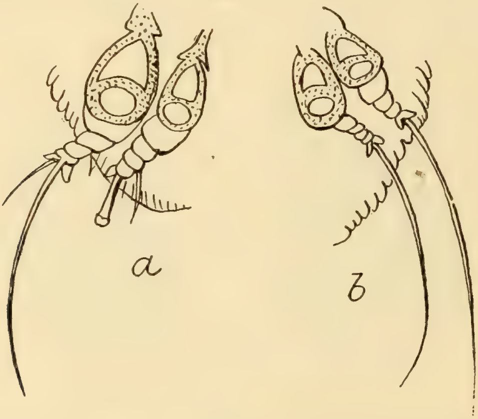

FIG. 162.—*Sarcoptes scabiei: a*, posterior legs of male; *b*, posterior legs of female (after Furstenberg, from Murray).

Infection with this parasite is accompanied with intense itching during the formation of pustules and inflamed areas, and while in man it is usually confined to the base of the fingers and between the knuckles, in aggravated cases the whole hand and arm may become invaded.

The "seven-year itch," "army itch," and "Jackson itch" are simply aggravated cases, where, from lack of good sanitation, the mites are able to thrive better than usual.

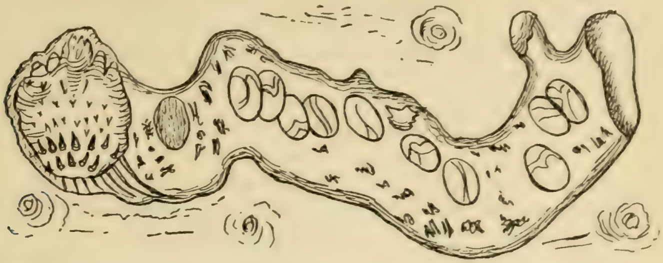

FIG. 163.—Burrow of itch mite in human skin, with eggs and mite—enlarged (after Furstenberg, from Murray).

In the human subject the application of sulphur ointment, in addition to frequent washing with soap and hot water, and for domestic animals the use of washes or dips, as for scab mites, are to be adopted.

ITCH MITE OF THE CAT.

(*Sarcoptes cati* Hering and Gerlach.)

I am not aware that this species has been observed in this country, but from the descriptions of it in the Old World it must be a very destructive species to the animal it infests. Our account is taken from Murray:

> On the cat and rabbit the species is a good deal smaller than the *Sarcoptes scabiei* The thorns or spines on the back begin to alter; on the thorax they are absent or turned into hairs, and there are now twelve thorns on the back of the abdomen.
>
> Both in the cat and the rabbit this parasite takes the head as its point of attack, and more particularly the base of the nose, the lips, the ears, and the eyes. Even when the animal is inoculated elsewhere by putting mites upon other parts of the body, and after they have actually taken possession and begun to burrow, they soon leave these parts and, making for the head, establish themselves about the nose and the ears. In its early stage the burrows, when sought for, can be easily seen, but the obstruction caused by the numerous hairs makes them more tortuous and often interrupted. As the mites increase, so do the burrows and the itching, and the cat scratches itself and tears the skin. Then the hairs fall off, and the parts around the eyes, nose, and ears become covered with hard crusts spread over and adhering to the suffering parts. The time that the mischief takes to reach this stage varies according to the age, strength, and condition of the cat. As a rule, the young and strong resist longer than the old and feeble. In them by the twentieth or thirtieth day it may have spread over the head, ears, nose, shoulders, and even the back and loins. The crust becomes harder and gray and agglutinated to the hairs, and under the crusts the specimens of the Sarcoptes may be found. By degrees, as the malady progresses and the animal becomes weaker, the skin increases in thickness, becomes hard, stiff, and forms voluminous folds round the neck. The swelling of the tissues increases and their inflammation extends to the nostrils, obstructs the respiration, and gives the head of the cat that elephantiasian appearance that occurs in the lion, and is indeed a constant character in cases of itch among feline animals.

When it has completely covered the head, it extends by degrees over the whole body; it is then impossible to describe the miserable condition of the poor animal, which the parasites are devouring as if it were a dead carcass—the feebleness is so great that it totters on its limbs and can scarcely drag itself along. All its skin is a focus of infection, where crusts and entangled hairs form pieces like hideous shells, and which pieces tear off in plates. It is true that they rarely reach this extreme stage, being usually destroyed before the disease passes through all the stages of complication. Still plenty of dead cats that have had the disease bad enough may be seen in the dust carts and on the manure heaps of all great towns. The most of them are either killed or die in cellars of houses where they have taken refuge.

In the country the complaint is much rarer, the opportunity for contagion being much less; but when it appears there it runs its course as rapidly as in towns. M. Delwart, of Brussels, said, in 1830, that he had seen on large farms, where a great many cats were kept, the malady spread itself with such rapidity that in four or five weeks all the cats had been carried off by the infection, and in 1827 M. Sajous, a veterinary surgeon, residing at Tarbes, related that a very intense epizootic itch had raged in that district among the cats for several years, and it proved so murderous that entire villages remained wholly deprived of cats. The malady seems to vary in virulence at different times, and when very bad it is called epizootic, when milder sporadic; differences which may be due to the character of the season or general robustness of the animal's health at different times.

The symptoms are the same in the rabbit when it is infected.

The remedies that are used for the itch in man should be used for this variety, and of course modified in their administration to suit the different characters of the patient.

In the country the cats may occasionally in autumn be seen suffering from great irritation, and people are apt to jump to the conclusion that they have got the itch. But it is always easy to tell whether it is so or not, for if the itch it shows itself about the head and nose and ears, and if, instead of that, the irritation is about the feet, ten to one it is caused by the harvest mite, *Leptus autumnalis*, which the cat has caught in wandering about the garden, and usually on examination the matter can be put beyond doubt by finding the little red mite in the fur or between the claws of the cat. If kept from getting a fresh supply, it will soon get better, for the mites will soon leave it of their own accord; but if allowed to get a fresh supply every day, it will of course get worse and worse as long as the supply is renewed.

Another variety of this species is the rabbit mite, var. *cuniculi*, which produces the same symptoms in rabbits and hares.

THE ITCH MITE OF FOWLS.

(*Sarcoptes mutans* Robin and Lanq.)

This species is a parasite on the domestic fowl. We owe our knowledge of it to M. Lanquetan, M. Reynal, and Professor Robin. A full description, with careful figures, will be found in the Bulletin of the Society of Moscow, 1860. It is a very flat, broad species, and the absence of spines on the back at once distinguishes it from all the preceding. The ailment produced by it is observed most frequently on the hen and cock, appearing first on the feet, on the comb, and about the beak. No premonitory symptoms indicate its approach. The fowls preserve their appetite and liveliness, although sometimes a careful observer may see that the sick animals shake their heads, raise and stretch their legs in a convulsive manner. If the examination is followed up some white points and lines traced in zigzag, covered by very small scales, which the least rubbing knocks off, may be seen on the comb. The skin covered by them is lightly chagrined and of a brown color, which contrasts with the red color of the rest of the comb. At that period no lesion of the tissues is observable. The malady remains stationary for fifteen days or even a month, at the end of which time the base of the comb thickens and becomes darker, and the linear tracings assume the appearance of true burrows of the itch insect, and at the bottom of them the *Sarcoptes mutans* is to be found. At a later period the feathers of the head and about the beak undergo a remarkable change. They turn back, stand on end, and lose their brilliancy: they become white and atrophied, as if there were some perversion of the secretion of the skin of the bulb. At the point where the feather detaches itself from the skin there is found a mass of epidermic matter in a bed of the thickness of some millimeters, and all around are lines or burrows formed by the raising of the skin.

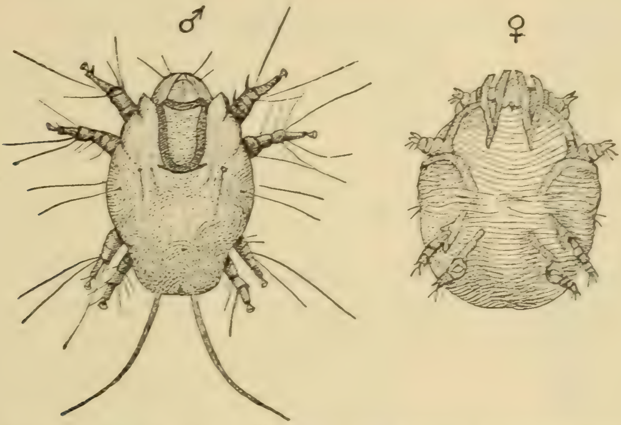

FIG 164.—*Sarcoptes mutans:* male and female (copied from Murray's figures reduced from Robin).

As the malady proceeds the feathers of the head and upper part of the body become atrophied; their free extremity bends, twists, and rolls upon itself, and ends by disappearing in the midst of the epidermal products accumulated at the base of the quill. The head and neck of the fowl have at that period a very peculiar aspect. They are despoiled of all the feathers that decorate them in their normal state. The comb is brown, with a rugged surface, drawn back upon itself, broad at its base, and spotted with whitish, mealy patches. On various parts crusts, of some lines in thickness, appear, which when detached leave a scaly surface, which recalls to mind the disease named phthiriasis. The complaint does not always begin on the head. It sometimes makes its first approaches on the feet. Similar symptoms occur there, but they proceed more slowly, but by and by the scales on the feet and legs begin to come off, and a crust forms upon them, more especially between the toes. Sometimes it envelops the whole of the foot and tibia, forming a crust a third of an inch in thickness. Bits as large as a hazel nut or a walnut may be broken off. This affection has much analogy with the Norwegian itch above described. It can be communicated both to man and the horse. (Murray.)

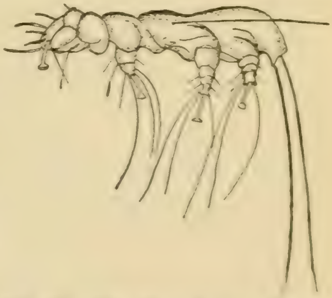

FIG. 165.—*Sarcoptes mutans:* side view (copied from Murray's figure after Robin).

THE SMOOTH SARCOPTES.

(*Sarcoptes lævis* Railliet.)

This species, described by Railliet in 1885, is represented by several varieties that live in the feather bulbs of birds, notably the pigeon and hen. It has not been observed as yet in America, but it is quite likely that it may be found to occur here.

Family DEMODECIDÆ.

This family includes only one genus, the description of which will indicate the family characters.

THE FOLLICLE MITE.

(*Demodex folliculorum* Simon.)

The follicle mites are rather degenerate worm-like forms that occur in the hair follicles of different animals, the variety occurring on man (*hominis*), producing the little specks or blackheads so frequent on the face, and which are said to be almost universally present, though it is seldom they cause any special irritation. The variety occurring on dogs (*Canis*), produces a serious disease, as does also the one on hogs (*Suis*). In both these animals the affected parts are the face and nose and occasionally larger tracts of the body.

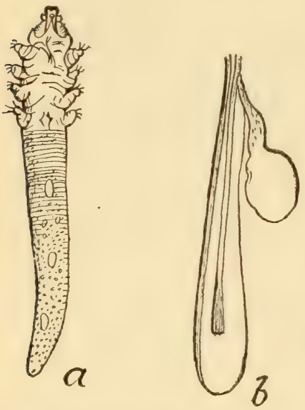

FIG. 166.—*Demodex folliculorum*, var. *hominis*: *a*, mite greatly enlarged; *b*, mites in hair follicle and sebaceous gland—enlarged (copied from Murray).

The variety on cattle affects the body at large and has a somewhat different interest, as it is recorded as damaging the hides for market. A record of its occurrence in this manner is given by Walter Faxon and also by Dr. C. W. Stiles.

The mites evidently undergo all stages of development in the follicles, but doubtless migrate over the surface of the skin when mature and before laying eggs.

The use of dips and washes would seem to be the only sure treatment for domestic animals, and if it is thought necessary a similar mode could be adopted for man.

Order LINGUATULINA.

This group, which includes a few species of remarkably modified Arachnids, may be recognized by the worm-like footless condition of the adult, two pairs of hooks at the sides of the mouth, and the rudimentary condition of the circulation and respiration. Only one species need be mentioned here.

Linguatula rhinaria Pilger.

The worm-like condition of this parasite may be inferred from the fact that it was originally described as a tapeworm (*Tænia rhinaria*), but its Arachnid affinities were early suspected, and with the determination of the early stages were proven beyond question.

In the adult worm-like stage it is a parasite in the nasal cavities of various animals, especially carnivores, the most common host, perhaps, being the dog.

The larval state occurs in the viscera of different animals, but more particularly those which are herbivorous—the horse, sheep, ox, goat, and many others—as well as man.

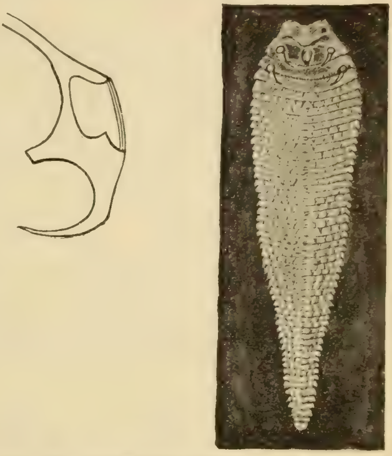

FIG. 167.—*Linguatula rhinaria:* larva in *serrata* stage—enlarged (copied from Van Beneden).

The migrations between these hosts, which are evidently an essential part of its existence, may be stated in brief to be the discharge of numerous eggs in the nasal cavitites of the dog or other host, which, in sneezing or coughing, spreads them over vegetation that later is taken as food by some herbivorous animal, and following this ingestion the embryos escape into the glands and viscera of the new host, occupying especially the mesenteric glands, liver, etc., where they remain in an inactive condition until fragments of the viscera containing them are eaten by a carnivore, when they gain access to the nasal cavities and become mature. In case they have not the fortune to be eaten by a carnivore, it is believed they may migrate within the body of their herbivore host, reencyst themselves in other organs, and even in some cases reach the nasal cavities by way of the lungs and air passages, thus accounting for the rare occurrence of the adult form in a herbivorous host.

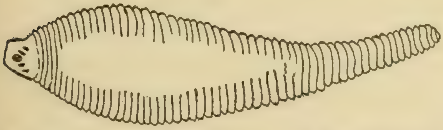

FIG. 168.—*Linguatula rhinaria:* adult (after Packard).

Curtice[1] records the occurrence of this species in America, the larval stage (*denticulatum*) having been taken from rabbits in two instances, once by Dr. F. L. Kilborne, in 1887, and once by himself, in 1888.

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[1] Animal Parasites of sheep, p. 69.

CHAPTER VII.

REMEDIES—PREVENTIVE TREATMENT.[1]

There are so many of the external parasites of domesticated animals, which, even though very widely different in structure and affinities, have very similar habit and can be reached by practically the same treatment, that a chapter devoted especially to general treatment will be of special importance. We may consider the subject under the heads of "Preventive measures," "Insecticidal substances," and "Methods of application of remedies."

PREVENTIVE MEASURES.

Prevention is for a large number of parasitic forms by far the most desirable plan. For some it is the only plan that can be of any service in avoiding injury.

The attacks of semiparasitic forms, as mosquitoes, flies, buffalo-gnats, etc., may be abated by operating upon their breeding places and, further, their direct attacks upon animals, where the number to be protected is not too great, may be prevented in some degree by smearing the hair of the animals with preparations of fish oil, tar, train oil, and axle grease. Pennyroyal is also recommended as beneficial.

For the bot-flies it is important to destroy the eggs before the larvæ hatch by shaving or clipping off those noticed on horses, or washing them with kerosene emulsion, carbolic acid solution, dipping solution, or, if a dipping vat is available, by swimming the animals through the vat.

For the constant external parasites, as lice, itch mites, etc., quarantine of all animals introduced into a herd or thorough treatment of such animals to prevent infection of a herd that is free cannot be too strongly urged. It is the most practical protection against these pests.

INSECTICIDAL SUBSTANCES.

In this enumeration of substances which may be used in treating insects affecting domestic animals, the aim shall be to include all that have a real value in this direction, either individually or in combination, and to indicate their valuable properties and very briefly the forms to which they may be applied.

Arsenic, a deadly poison, is used in some of the dipping solutions and kills quickly when taken into the alimentary canal or penetrating the tissues of the insect. It is, however, too dangerous a poison to be used except with the greatest care, and the possibility of the animal treated licking itself or eating food upon which the solution has dripped to such an extent as to get a poisonous dose is too great to give it strong indorsement. It has its greatest value in this connection in treatment of sheep scab, which often resists more simple remedies.

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[1] Dr. D. E. Salmon, Chief of the Bureau of Animal Industry, has very kindly read and revised this chapter.—L. O. H.

Carbolic acid, one of the most effective of agents against parasites and especially in certain combinations, is to be highly recommended. In many cases the crude article can be used to as great advantage as the refined and at great saving in cost. Used externally without other combination than with water, it should have a dilution of about 100 times its bulk of water. If used too concentrated or upon very susceptible animals such as dogs, it may be absorbed and cause poisoning. Dr. Francis recommends it very highly in combination for cattle ticks, and the Poultry World gives it the highest praise as a combination with slaked lime, to be used in buildings for chicken lice.

Calomel is used in some cases, but is for the most part superseded by more satisfactory remedies.

Benzine may be used in the form of a spray or wash against bed-bugs and fleas, and in chicken houses against ticks, though for this purpose it has no advantage over kerosene emulsion.

Gasoline may be used in the same way and for the same purpose as benzine. Both must, of course, be used with due regard to their inflammable properties.

Cotton-seed oil is strongly recommended by Dr. Francis for treatment of ticks in the Southern States, especially in connection with dipping solutions. Its action is similar to that of other oils, and while it kills some of the ticks, there are others on the same animal which apparently are not injured by it. In the States where cotton is produced and the oil can be secured at low cost it has special advantages, either alone or combined with other remedies as an application for various external parasites.

Kerosene has a wide range of usefulness in the treatment of parasites notwithstanding the fact that it does not seem to have fulfilled the requirements for a good dipping solution. It may be used free for the spraying of the interior of chicken houses, for the destruction of bed-bugs, and for filming the surface of small ponds, water tanks, etc., in order to destroy mosquitoes or their larvæ and abate the mosquito nuisance. In emulsion it is very effective against lice on cattle, killing both adults and eggs, for use as a spray to kill horn-flies, and as a wash to kill eggs of bot-flies or lice.

Emulsions may be made with either soap or milk and according to the following well-known formulæ:

Milk emulsion.—To one part milk add two parts of kerosene, and churn by a force pump or other agitator. The creamy emulsion which results is to be diluted with water, using eight or ten times the bulk of water.

Soap emulsion.—Dissolve one-half pound hard soap in 1 gallon of hot water, and while still at near boiling point add 2 gallons kerosene, and emulsify by use of force pump or agitator of some kind. Dilute with water one part emulsion to eight or ten parts water, and use as spray, wash, or dip.

Oil of turpentine is recommended as an application for external parasites, but should not be applied to the skin of horses, though when suitably mixed it is sometimes prescribed for bots in these animals.

Coal tar is useful as a barrier to mites and lice in the poultry house.

Dust and *ashes* are natural remedies used by fowls.

Lime in form of fine slaked dust mixed with carbolic acid and scattered throughout the buildings or applied as whitewash is one of the best remedies for chicken pests, as well as for the lice and mange insects of other animals which infest stables and fences. It is also used as one of the ingredients in sheep dips.

Pyrethrum powder, known also as Persian insect powder, "Buhach" (the California brand), and Dalmatian insect powder, is a most excellent parasiticide, and the powder dusted in rooms troubled with fleas, lice, or bed-bugs, on dogs, cats, chickens, etc., is very effective. It has been found to be the only satisfactory remedy for lice and ticks on sheep in winter, when the long wool prohibits other treatment.

Sulphur as a fumigating material or dusted on the skin, in ointments and in dipping solutions, has a great range of usefulness.

Tobacco is a very effective agent against parasites and in fumigation, in dipping solutions, and in form of snuff dusted among hairs or feathers is applicable to many external parasites.

METHODS OF APPLICATION OF REMEDIES.

In the treatment of the different parasites there is room for much choice both as to the material used and the manner of its application. Treatment that is possible on a few animals or in a closed room may be absolutely prohibited on a large scale, or with herds of animals in pasture or ranch, and that which may be applicable in summer may be dangerous or out of the question in winter; so it will be seen that in giving methods it is expected that each individual is to study the conditions and adapt the treatment to his particular case.

DIRECT CAPTURE OR DESTRUCTION OF INSECTS.

There are many occasions when the use of a little dexterity may accomplish the destruction of an annoying bot-fly, horse-fly, or swarm of mosquitoes. Picking the cattle tick by hand and burning it is the most reliable method which has yet been proposed for its destruction. A stroke of the hand or a wisp of grass, a strap or even a whip may accomplish the desired end, while sprays of kerosene emulsion may be used to destroy clusters of flies and mosquitoes on cattle as they come from the pastures in evening.

A trap arranged at a stable door for catching flies from the backs of cattle has been described in many agricultural papers, and the following description applies evidently to a somewhat more complicated arrangement for this purpose:

> A machine for catching flies from the backs of cattle, and so affording the animals relief and comfort, has been invented by a farmer in Madison County, Ky. The flycatcher is a kind of covered pen or passageway, through which the animal must walk to secure relief. A few feet from the entrance there is a cupola, or dome, in the roof of the passageway, made of glass and arranged as a flytrap. Beyond this the passageway is in darkness. The animal walks through the machine, and just as it passes the dome and enters the darkened part a set of brushes sweeps off the flies, which naturally rise into the lighted dome, and the steer passes out at the other side free from flies. The flies are retained in the dome trap. The inventor has experimented with his machine, and finds that animals soon learn the value of the machine and know enough to walk through it when the flies begin to bite. The device is said to be patented, but a plan involving the same principles has been in use among farmers for the destruction of horn-flies for a year or two past.—*Denver Field and Farm, April 25, 1896.*

According to The Homestead, "the device above referred to was invented by a Canadian farmer named Guthrie in 1894 and was described very fully in the July number of the Canadian Live Stock and Farm Journal. A description of it also appeared in these columns in the same month, the horn-fly being a very serious pest that season."

RENOVATION OF HENHOUSES.

The treatment of henhouses that have become infested with lice, mites, and ticks is often a vexatious matter, and the writer thinks that if the structure is not too valuable the best plan would be to burn the whole outfit, submit the fowls to a thorough quarantine, with applications of pyrethrum powder or other effective insecticide to free their bodies, and build a new henhouse on fresh ground as far as may be from the site of the old one. Where such a method is impracticable, and of course it may usually be so, a thorough fumigation with sulphur, if the walls are tight enough to retain the fumes, or the application of a spray of kerosene or gasoline to the interior, the drenching of all roosts with kerosene or hot water, followed by whitewashing, and the use of tar on the ends of the poles and wherever they come in contact with supports are pretty sure to bring success. The addition of 4 ounces of crude carbolic acid to the gallon of whitewash increases its efficiency for this purpose. Repeated applications may be necessary, but due attention to reaching all points to which the pests resort will keep the nuisance in check at least.

In this connection, it may be well to include a paragraph from Poultry World detailing a method which appears to be valuable, although the writer has not personally experimented with it.

Dr. Spaulding says:

> I promised you a specific against all manner of mischievous insects that infest the poultry house and nests. Something surer and more convenient than fumigation and whitewash, and so speedy and simple that when once employed the poultryman fastens his hold upon it as an entirely satisfactory specific. I take for 600

> square feet of house room one-half bushel of lime, place it in a box in the open air and sprinkle with water and secure complete pulverization; in other words, slack the lime perfectly, let it get entirely cool, and then to this half bushel of pulverized lime add 10 pounds of sulphur and 1 ounce fluid carbolic acid, and stir the whole with a stick until well mixed. Then it can be safely handled with the hand. After sweeping out the henhouse, drive out all the birds, close all the doors and windows, and begin at the farther end and walk backward, scattering the mixture freely all over the floor and through the air onto the perches and into the nests everywhere thoroughly, and it is difficult to conceive how dense the cloud of medicated dust that will hang suspended through the whole interior of the house. Gradually it settles everywhere, in every crack and crevice, and wherever it reaches a henlouse or other insect he retires from business permanently. It purifies as if by fire. I think there is nothing equal to it for thoroughness, cheapness, and expedition. If the chicks have roup, leave them in the house and let them stem the storm; it won't kill nor hurt them, but the sneezing will be terrific, and every particle of mucus that has accumulated in the air passages and throat will be expelled.

Stocking the poultry yard at the start by rearing eggs in an incubator and never introducing a fowl to bring parasites, should avoid many of the worst poultry parasites.

FUMIGATION.

Fumigation as a method of treatment has a limited value, but there are circumstances under which it may be of great service. It involves too much expenditure of labor and time to prove of general value. In winter time, when washes or dips are unsafe from danger of chilling the animals, it can be used to advantage. As a general plan, however, the writer would recommend the use of other measures at times of the year when this objection will not hold. Either sulphur or tobacco may be used, but the latter seems in some respects preferable. Fumigation with sulphur is sometimes available in vacant buildings or rooms to clear them of bed-bugs, fleas, and other pests, and may be adopted for henneries that can be tightly closed. Sulphur should always be burned in an iron vessel to avoid danger from fire, and if previously moistened with alcohol much trouble will be avoided in causing it to burn.

A simple plan of fumigation for cattle and horses is to cover the animal with a blanket or air-tight canvas kept as free from the body as possible and to puff fumes of tobacco from a bee smoker under the edge.

A permanent box stall may be made just large enough to accommodate the larger animals, with an opening for the head, the animal being held by a stanchion. The opening must be provided with a close canvas, arranged so that when the animal's head is in place the edge of the canvas can be drawn down tight just behind the eyes, thus inclosing every part but the mouth, nose, and eyes. A tight door must be arranged to close behind the animal, and the fumes may be introduced by puffing from a bee smoker or by burning tobacco or sulphur in a tin or sheet-iron tube passed through at some point on the side, the outer end being closed and the heat applied by using a small oil stove, with due precautions to avoid communication of fire to the building. It has been found that by this plan cattle lice could be killed by an exposure of fifteen to twenty minutes, but in some trials on sheep it was ineffective even with an hour or two of dense fumes, the long matted wool evidently protecting the parasites. In the experiments the sheep had wool 6 inches or more long. When out of the wool the insects succumbed quickly to fumes.

WASHES AND DIPS.

Applications of liquid remedies are the main reliance in the treatment of external parasites, and the choice between methods depends largely upon the amount of work to be done.

The most available substances are the solutions of tobacco, diluted carbolic acid, kerosene emulsion, infusion of stavesacre for lice, or some of the regular sheep dips.

For lice on cattle a wash of kerosene emulsion rubbed on with a rag or the hands to the parts where eggs and lice are most abundant can be used even in winter, with some care to avoid exposure, and while not usually reaching every louse, will suffice to keep the pests in check.

Tobacco decoction.—A simple tobacco decoction is made by steeping tobacco leaves and stems in water. Such decoctions are poisonous to most animals and should not contain more than 2 to 5 per cent of tobacco. With horses they should only be applied to a part of the body at one time.

Tobacco and sulphur dip.—A combination especially favored in Australia, given by Curtice, consists of tobacco and sulphur, of 1 pound each to every 4 gallons of water to be used, the tobacco solution and sulphur being stirred together till of a creamy consistency and then diluted with required amount of water.

Sulphur and lime dip.—Flowers of sulphur 25 pounds, quicklime 20 pounds, water 100 gallons. Lime is first slacked in usual manner, then the rest of the water and the sulphur are added. Boil for twenty minutes and strain well. Hold the sheep in the mixture until the scabs are thoroughly soaked. Immerse the head at least once. Use the dip at 100° to 110° F. Dip twice, with an interval of ten days. The ingredients should be carefully sifted before mixing, and the sediment should not be thrown into the tank.

Tobacco, sulphur, and lye dip.—Thirty pounds of tobacco, 7 pounds of sulphur, 3 pounds of concentrated lye, dissolved in 100 gallons of water.

Law's dip.—Tobacco 16 pounds, oil of tar 3 pints, soda ash 20 pounds, soft soap 4 pounds, water 50 gallons. Sufficient for 50 sheep. The tobacco should be steeped, afterwards the other ingredients added at 70° F.

Cotton-seed oil.—This is claimed by Dr. Francis to give on a large scale the most satisfactory results for ticks. The oil is simply poured on a vat filled with water, the cattle being drenched with it as they emerge.

For a few animals a small vat is sufficient, and pigs, lambs, dogs, etc., may be dipped in a tub or barrel. There is a patented dipping device for lowering animals into a tank.

Wherever dipping is to be practiced to any great extent the construction of a permanent tank or vat for the purpose will be a matter of economy.[1]

The following description of the method of constructing a dipping vat is from an article in the Texas Farm and Ranch, by Dr. M. Francis, of the Texas Agricultural and Mechanical College. It is so clear in explanation that anyone should be able to construct a vat fitted for the purpose. If the vat is intended for dipping sheep or small animals only it may be made smaller, but it would evidently be in proportion, and if it is intended to keep the vat constantly filled ready for use it might be preferable to have one for horses and cattle and a smaller sized one, with the proper dipping solution, for sheep, hogs, dogs, etc. It is thought, however, that by the use of a false bottom, so as to prevent any possibility of the smaller animals failing to get out of the larger vat, that all animals could be treated in one of large enough size to accommodate the largest animals.

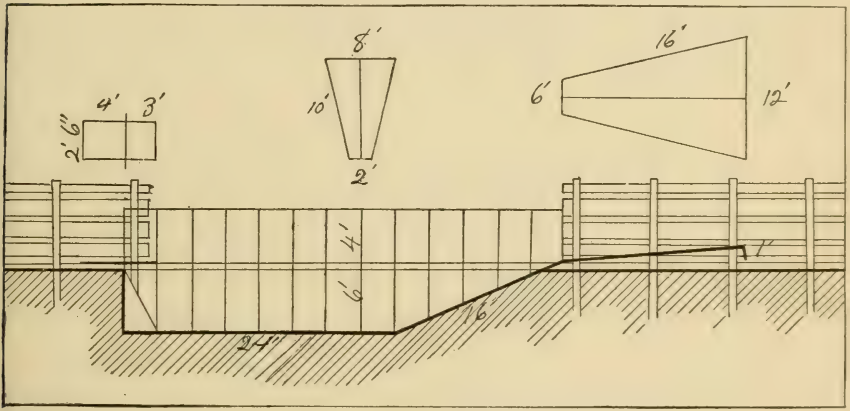

Fig. 169.—Section of dipping vat.

Dr. Francis's description was in the form of a reply to Mr. James M. Niall, Rockhampton, Queensland, Australia:

Mr. James M. Niall,
Rockhampton, Queensland, Australia.

Dear Sir: Yours of December 24 is before me. Ticks have become such a curse in this country that we have been compelled to devise some means for their destruction. After various unsuccessful attempts in this direction, we have adopted the dipping process with very gratifying results.

We use a large vat of 5,000 gallons capacity and force the cattle to swim through it. Without further remarks, I will now describe the arrangement and its operation. (See fig. 169.)

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[1] Many of the patented or registered dips are valuable and, if the user does not object to paying a higher price for the ingredients used, may be utilized.

In selecting a location for a vat I would advise a point to which water is convenient. This may be furnished by a wind pump, pond, or stream. I would avoid waters containing minerals or alkali. I know of no objection to salt water.

Excavate a trench 7 feet deep, 4 feet wide in bottom, and 24 feet long, in which to build the vat.

In doing this considerable of the work can be done by plowing and scraping the dirt out at one end and dumping it so as to form a mound on which to build the dripping platform.

The trench must be completed by hand labor by throwing the dirt out in about equal quantities on each side.

Lay in bottom of trench 2 pieces of 4 by 4 inches by 24 feet long 34 inches apart; lay them parallel and level. On these nail cross pieces 2 by 4 by 43, 18 inches from centers beginning at square end of trench. This will require 17 pieces 2 by 4 by 48. Cut 34 pieces 2 by 4 by 10 for uprights. Nail lower ends of uprights into sills and cross pieces, and slant upper ends outward, making upper ends 8 feet apart.

Having done this continue the 4 by 4 inch bottom sills 16 feet up the incline and make the outer ends 6¾ feet apart so that the uprights to be attached will come in line with those already in place.

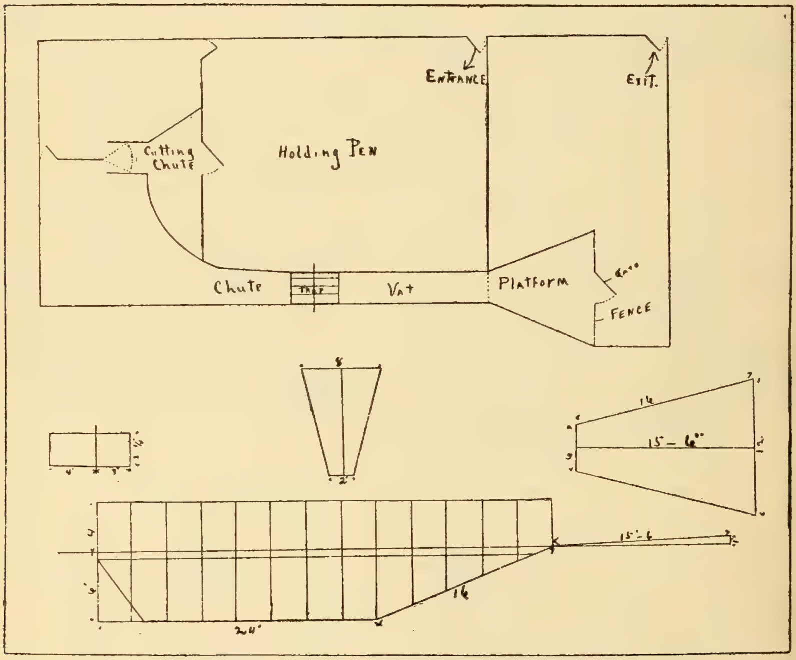

FIG. 170.—Diagram of sheep pens, showing location of dipping vat below.

Put cross pieces on sills as in bottom. Each cross piece will be longer as you go up, and uprights will be shorter.

Fill and tamp around the sills and cross pieces thoroughly. For floor and siding we use 2 by 4 by 16 pine, dressed and matched, laid in white zinc paint, both secret and face nailed with sixteenpenny wire nails.

Mr. R. J. Kleburg, who built the first vat I know of, used 2 by 12 cypress floor and siding, and calked joints with oakum.

Extend the siding 8 feet high to prevent waste of dip from splashing. Box up square end of vat 6 feet, cleat the incline with 2 by 4 pieces 18 inches apart for cattle to secure a footing. Brace the vat crosswise by using 2 by 6 by 9 stuff, well nailed into top of uprights. This is very important as it prevents bulging and collapse.

The dripping floor is built at the exit from the vat and slopes 1 foot, draining into vat. It should be cleated to prevent slipping of cattle. It is important that the exit and dripping platform be 1 foot above water line to check waves and prevent waste.

We have not found a drainage pipe necessary. Fill in around the vat up to ground line and tamp well. Inclose dripping floor with a strong fence and provide a gate.

Chute and trapdoor.—Make a long narrow chute, 3 feet wide, leading to vat, and box up sides tight, so cattle can not see out. Sink two posts 6 by 6 by 8 at end of chute as close to end of vat as possible and bore 1½ inch auger holes through the posts at ground line, and put a 1¼-inch iron pipe through on which to balance the trapdoor.

Allow boxing of chute to project 3 feet into vat. Make trapdoor of heavy material, 7 feet long, 2¾ feet wide, and attach same to axle so as to allow 4 feet to project into chute and 3 feet into vat. Thus arranged it will fall back into place after being tilted. It is desirable, though not necessary, to face trapdoor with boiler iron, as it will cause cattle to slip readily and because wood soon wears out.

Construct pens something like diagram. (See fig.170.) You may find overflow pipes desirable in case of heavy rains. These consist of 1-inch or 1¼-inch iron pipe, 2 feet long, one elbow and another pipe, say, 8 or 10 inches. Put long end in vat and short end through hole in side of vat about 5½ feet from bottom, or at water line. In case of flooding this will allow the water to escape and will hold the oil. The arrangement described above has been in operation at this station two years and has proved so satisfactory that I have no change to suggest.

Our vat cost about $100. I think it could be duplicated almost anywhere for $150.

CHAPTER VIII.

LIST OF PARASITES ACCORDING TO HOSTS.

In the following list of insects affecting domestic animals no attempt is made to enumerate such as lead an independent existence and make their attacks on a great variety of animals.

The mosquitoes, flies, bugs, ticks, etc., which have no definite host could be included under almost every species.

The only exceptions made are in cases where species of special importance have a decided preference for certain animals, as the horn-fly and cattle tick for cattle.

Further, the list is intended to be a key to the species treated in this work and not to enumerate every species that has ever been recorded on any species of animal.

AFFECTING MAN.

The ox bot-flies (*Hypoderma lineata* and *bovis*) (accidental).

Bot-fly (*Dermatobia noxialis*).

The bot-fly (*Dermatobia cyaniventris*).

The screw worm (*Compsomyia macellaria*).

The house flea (*Pulex irritans*).

The dog flea (*Pulex serraticeps*).

The jigger flea (*Sarcopsylla penetrans*).

The crab louse (*Phthirius inguinalis*).

The head louse (*Pediculus capitis*).

The body louse (*Pediculus vestimenti*).

The itch mite (*Sarcoptes scabiei* var. *hominis*.)

The follicle mite (*Demodex folliculorum* var *hominis*).

AFFECTING APES AND MONKEYS.

The ape louse (*Pediculus consobrinus*).

The monkey lice (*Pedicinus* spp.).

AFFECTING THE DOG.

Bot flies (*Dermatobia noxialis* and *cyaniventris*).

Screw-worm fly (*Compsomyia macellaria*).

The dog flea (*Pulex serraticeps*).

The sucking dog louse (*Hæmatopinus piliferus*).

The biting dog louse (*Trichodectes latus*).

The dog tick or wood tick (*Dermacentor americanus*).

The itch mite (*Sarcoptes scabiei* var. *canis*).

The follicle mite (*Demodex folliculorum* var. *canis*).

Linguatula rhinaria.

AFFECTING THE CAT.

Bot-fly (*Dermatobia noxialis*).

Screw worm (*Compsomyia macellaria*)

The dog or cat flea (*Pulex serraticeps*).

The cat louse (*Trichodectes subrostratus*).

The itch mite of the cat (*Sarcoptes minor* var. *cati*).

The cat chorioptes or ear mite (*Chorioptes auriculorum* var. *felis*).

AFFECTING THE FERRET.

Ferret louse (*Trichodectes?*).

The ferret chorioptes (*Chorioptes auriculorum furonis*).

AFFECTING THE HORSE, ASS, AND MULE.

Common bot fly (*Gastrophilus equi*).

Red-tailed bot fly (*Gastrophilus hæmorrhoidalis*).

The chin fly (*Gastrophilus nasalis*).

Gastrophilus pecorum and *Gastrophilus* sp.

The horse tick; forest fly (*Hippobosca equina*).

The suctorial horse louse (*Hæmatopinus macrocephalus*).

The biting horse louse (*Trichodectes parumpilosus*).

Trichodectes pilosus.

The itch mite or mange insect (*Psoroptes communis*, var. *equi*).

The itch mite (*Sarcoptes scabiei*, var. *equi*).

The horse symbiote mite (*Chorioptes symbiotes*, var. *equi*).

Linguatula rhinaria larva, adult (occasional).

AFFECTING CATTLE.

Ox bot-fly; warble fly (Europe), *Hypoderma bovis.*

Ox bot-fly; warble fly (in America), *Hypoderma lineata.*

The horn fly (*Hæmatobia serrata*).

The screw worm (*Compsomyia macellaria*).

Short-nosed ox louse (*Hæmatopinus eurysternus*).

Long-nosed ox louse (*Hæmatopinus tenuirostris*).

Biting ox louse (*Trichodectes scalaris*).

Itch mite of cattle (*Chorioptes symbiotes*, var. *bovis*).

Itch mite of cattle (*Sarcoptes scabiei*, var. *bovis*).

Scab mite of cattle (*Psoroptes communis*, var. *bovis*).

The cattle tick (*Boöphilus bovis*).

The lone star tick (*Amblyomma unipunctata*).

Follicle mite (*Demodex folliculorum*, var. *bovis*).

Linguatula rhinaria (larval stage).

AFFECTING SHEEP.

Sheep bot-fly (*Œstrus ovis*).

Screw worm (*Compsomyia macellaria*).

Sheep tick (*Melophagus ovinus*).

Sheep foot louse (*Hæmatopinus pedalis*).

Sheep louse (*Trichodectes sphærocephalus.*)

Sheep scab mite (*Psoroptes communis*, var. *ovis*).

Sheep foot scab mite (*Chorioptes symbiotes*, var. *ovis*).

Sheep itch mite (*Sarcoptes scabiei*, var. *ovis*).

AFFECTING THE GOAT.

Goat louse (*Hæmatopinus stenopsis*).

Biting goat louse (*Trichodectes climax*).

Louse of the Angora goat (*Trichodectes limbatus*).

Goat scab mite (*Psoroptes communis*, var. *capræ*).

Goat itch mite (*Chorioptes symbiotes*, var. *capræ*).

Itch mite (*Sarcoptes scabiei*, var. *capræ*).

AFFECTING SWINE.

Screw worm (*Compsomyia macellaria*).

Hog louse (*Hæmatopinus urius*).

Follicle mite (*Demodex folliculorum*, var. *suis*).

AFFECTING RABBITS AND HARES.

Rabbit bots (*Cuterebra cuniculi, horripilum* and *fontinella*).

Rabbit fleas (*Pulex goniocephalus, inæqualis*).

Rabbit lice (*Hæmatopinus ventricosus*).

Itch mite (*Sarcoptes scabiei*, var. *suis*).

AFFECTING CHICKENS.

Chicken flea (*Sarcopsylla gallinacea*).

Flea (*Vermipsylla alakurt*).

Chicken bug (*Acanthia inodora*).

Chicken lice (*Goniocotes gigas, hologaster, burnetti; Goniodes dissimilis; Lipeurus variabilis, heterographus; Menopon pallidum, biseriatum*).

Chicken tick (*Dermanyssus gallinæ*).

Chicken tick (*Argas americanus*).

Chicken mites (*Cytodites nudus, Laminosioptes cysticola, Sarcoptes mutans, S. laevis* var. *gallinæ*).

AFFECTING THE TURKEY.

Turkey gnat (*Simulium meridionale*).

Turkey lice (*Goniocotes rectangulatus, Goniodes stylifer, Lipeurus polytrapezius*).

AFFECTING THE PEAFOWL.

Peacock louse (*Goniodes falcicornis*).

AFFECTING PIGEONS.

Pigeon bug (*Acanthia columbarius*).

Pigeon lice (*Goniocotes compar, Goniodes minor* and *damicornis, Lipeurus baculus*).

Pigeon tick (*Argas reflexus*).

Pigeon plume mite (*Falciger rostratus*).

AFFECTING DUCKS, GEESE, AND SWAN.

Duck lice (*Docophorus icterodes, Lipeurus squalidus, Trinoton luridum*).

Lice of geese (*Trinoton jejunum, Trinoton conspurcatum*).

Swan lice *Docophorus cygni, Ornithobius bucephalus*).

Lice of the guinea hen (*Goniodes numidianus*).

CHAPTER IX.

LITERATURE.

The following list of works upon the subject of parasitism includes those of greater importance, and especially those containing original matter referring to American species. The enumeration of all papers bearing on the subject which was at first contemplated would have so enormously increased the space required that it was deemed inexpedient. The titles collected in the progress of the work would alone fill a volume. Moreover, it is assumed that any student who would need such a complete bibliography must have access to some of the general records of zoology and entomology which would answer his special purpose:

Parasites in General.

Albin, Eleazar.—A Natural History of Spiders, and Other Curious Insects. London, Montagu, 1736, p. 76, p. 8.

Children, John George.—Catalogue of Arachnida and Insects. Back's Voyage au pole du nord. 1836. Pg. 11. Appd., p. 532.

Description of the articulated animals collected in the northwest expedition of Captain Back.

Curtice Cooper.—The Animal Parasites of Sheep. Bureau of Animal Industry, U. S. Dept. Agr. 1890.

Gurlt, Ernst Friedr.—Verzeichniss der Thiere, auf welchen Schmarotzer-Insecten leben. Wiegm. Archiv. 1857. T. 23, pp. 276–311.

Gurlt, E. F.—Die auf Hausvögeln und Säugethieren lebenden Schmarotzer-Insecten. Mag. f. d. gesammte Thierheilkunde 1842. Jahrg. VIII. St. 4, p. 409. Jahrg. IX, St. 1, p. 1, tab. 1.

Gervais, Paul.—Histoire naturelle des insectes aptères. Paris, 1844. 3 vols.

Kollar, Vincent.—A Treatise on Insects Injurious to Gardeners, Foresters, and Farmers. 1840.

Chapter on parasites.

Mégnin, P.—Les Parasites et Les Maladies Parasitaires chez l'homme, les Animaux domestiques, etc. 478 pp., 65 figs., and 26 pl. Insectes, Arachnides, Crustacés. Paris, 1880.

Neumann, L. G.—A Treatise on the Parasites and Parasitic Diseases of the Domescated Animals. Translated by George Fleming. London, 1892. 800 pp., 364 figs.

General work. Very complete. Less full for insects than vermes.

Osborn, H.—External Parasites of Domestic Animals. Rept. Stock Breeders' Assoc. Reprint Bull. Ia. Ag. Col.; Dept. Ent. 1884.

Packard, A. S.—Certain Parasitic Insects. (Illustr.) Am. Nat., Vol. IV, p. 83.

Packard, A. S.—Our Common Insects.

Includes mention of many insects affecting domestic animals.

Packard, A. S.—Guide to Study of Insects. Fourth ed. Salem, 1874.

Includes mention of many species of insects affecting domestic animals.

Packard, A. S.—Half-Hour Recreations in Natural History. Division First—Half Hours with Insects. Boston, 1874–75. Relations of Insects to Man (pp. 65–96, figs. 54–70). Unity of Creation: Account of some Human Parasites, some stinging, some poisonous, and some useful insects and Arachnids.

Railliet, A.—Traité de Zoologie Médicale et Agricole. Paris, first ed., Part I, 1885. Part II, 1886. Second ed., Paris, 1895. Pp. 1303.

Riley, C. V.—Insects in Relation to Agriculture. Stoddard's Encyclopedia Americana, 1883, Vol. I. Pp. 135–142, figs. 1–29.

Insects injurious to live stock; bot fly of cattle (*Hypoderma bovis*); sheep bot fly (*Œstrus ovis*); horse bot fly (*Gastrophilus equi*).

Van Beneden.—Animal Parasites and Messmates. International Science Series.

Verrill, A. E.—The External and Internal Parasites of Man and Domestic Animals. Hartford, Conn., 1870, T. (?), p. 140. Reprint from Report of Connecticut State Board of Agriculture.

Williston, S. W.—Diptera. Standard Natural History, Vol. II, pp 403–433.

Discusses numerous species of Diptera that affect man and domestic animals.

Zürn, F. A.—Die Schmarotzer auf und in dem Körper unserer Haussäugethiere. Erster Theil: Die thierischen Parasiten. Weimar, 1882.

DIPTERA.

Coquerel, Charles.—Nouveau cas de mort produite par la Lucilia hominivorax et description de sa larve. Ann. Soc. Ent. Fr., ser. 3. 1859. T. 7, pp. 233–237, fig.

Kilpatrick, A. R.—The Screw Worm. Am. Ent., Vol. III., p. 275.

Riley, C. V.—Screw Worm. Its parentage in doubt. Am. Ent., Vol. III, p. 203.

Riley, C. V.—Abnormal Prevalence of Blow Flies. Am. Ent., Vol. III, p. 21.

Note, and copy of account of injuries by blow flies. Referred to *Lucilia macellaria* as probable cause.

Riley, C. V.—Prevalence of the Screw Worm in Central America. Amer. Nat., April (Mar. 15), 1883, Vol. XVII, p. 423.

Extract from letter of J. C. Zeledon on the abundance and ravages of *Lucilia macellaria* and related flies in Costa Rica.

Riley, C. V., and Howard, L. O.—The Horn Fly. Insect Life, Vol. II, pp. 93–103, 1889.

Full account of life history, habits, and investigations as to remedies.

SIMULIIDÆ.

Barnard, W. S.—Notes on the development of the Black Fly (*Simulium*), common in the rapids around Ithaca, N. Y. Am. Ent., Vol. III, p. 191, 1880. (Figure of eggs.)

Dodge, C. R.—Field and Forest, Vol. I, p. 2, 1875–76.

Unusually great killing of horses and mules in the south central United States by "buffalo gnats" in the spring of 1875.

Howard, L. O.—Notes on a Simulium common at Ithaca, N. Y. Insect Life, I, 99–101, Oct. 1888.

McBride, Sara J.—The so-called Web Worm of Young Trout. Am. Ent., Vol. II, p. 365.

Followed by editorial note by C. V. Riley.

Osten Sacken.—On the transformations of Simulium. Am. Ent., Vol. II, p. 229.

Figures after Verdat and Osten Sacken. References to authorities.

Riley, C. V.—Report of Entomologist. Ann. Rept. U. S. Comm. Agr. for 1886, pp. 459–592, 11 pl.

Buffalo gnats, etc. (pp. 492–515). Detailed account of life history, habits, etc.

Riley, C. V.—The Southern Buffalo-Gnat (*Simulium pecuarum*). Ann. Rept. Dept. Agr. for 1884, p. 340–345.

Riley, C. V.—The Buffalo Gnat Problem in the Lower Mississippi Valley. Abstract, Proc. Amer. Assoc. Adv. Sci. for 1887, May, 1888, Vol. XXXVI, p. 362.

Result of late investigations on species of Simulium.

Riley, C. V.—Simulium from Lake Superior. Amer. Nat., November (28 Oct.), 1881, Vol. XV, p. 916.

Notice of paper by H. A. Hagen; larvæ and pupæ from Lake Superior similar to those of *S. pictipes*, but the imagos from the same localities are different.

Riley, C. V.—Death of Mules Caused by Insects. Am. Ent., Vol. I, p. 148.

Riley, C. V.—The Death Web of Young Trout. Am. Ent., Vol. II, p. 174.

Copy of an article from Wilkes's Spirit of the Times, with editorial comment.

Riley, C. V.—The Death Web of Young Trout. Am. Ent., Vol. II, p. 211.

Riley, C. V.—The Death Web of Young Trout. Am. Ent., Vol. II, p. 227.

Riley, C. V.—Editorial note on article by Sara J. McBride, entitled "The so-called web-worm of young trout." Am. Ent., Vol. II, pp. 366-367.

Describes *Simulium piscicidium.*

Verdat, G. J.—Mémoire pour servir à l'histoire des Simulies, genre d'insectes de l'ordre des Diptères, famille des Tipulaires; lu à la réunion de la Société helvetique des Sciences naturelles à Bâle, le 25. Juillet 1821.

Verdat, G. J.—Geschichte d. Simulien in Naturwiss. Anz. d. allg. Schweiz. Gesellsch., 1822, No. 9, and in Thon's archiv., Vol. II.

Webster, F. M.—Report on Buffalo Gnats. Bull. No. 14, Div. Ent. U. S. Dept. Agric., p. 29. 1887.

ŒSTRIDÆ.

Allen, Charles H.—Demonstration of locomotion in the larvæ of the Œstridæ. Proc. Amer. Assoc. Adv. Sci., Vol. XXIV, pp. 230–236.

Statement of a case in which larvæ, of probably *Hypoderma bovis*, moved, respectively, 1, 6, and 30 inches under the skin of a boy. Notes on other larvæ of Œstridæ.

Arture.—Observations sur l'espèce de ver nommé Macaque (*Œstrus*). Mem. Acad. Paris, 1753. Hist., p. 72, ed. in 8. Hist., p. 106 (cf. Percheron 1, p. 11).

Bloch, Marcus Eliazar.—Beiträge zur Naturgeschichte der Würmer, welche in andern Thieren leben. (Œstrus.) Beschäft. Berl. Gesellsch. Naturfor., 1779, pp. 534–561.

Brauer, F.—Die Œstriden des Hochwildes, nebst einer Tabelle zur Bestimmung aller europäischen Arten dieser Famile. Verhandl. Wien Zool. Bot. Gesellsch., 1858, pp. 385–414.

Brauer, F.—Neue Beiträge zur Kenntniss der europäischen Œstriden. Verhandl. Wien Zool. Bot. Gesellsch., 1858, pp. 449–478.

Brauer, F.—Monographie der Œstriden. Herausgegeben von der K. K. Zool. Bot. Gesellschaft in Wien. Wien, 1863.

Coquerel, Charles.—Note sur une larve d'Œstride extraite du bras d'un homme à Cayenne. Revue et Magaz. Zool., ser. 2, 1859, T. II, pp. 356–361.

Coquerel, Charles.—Note sur les larves d'Œstrides développées chez l'homme au Mexique et à la Nouvelle Orleans (avec Sallé). Revue et Magaz. Zool., ser. 2, 1859, T. II, pp. 361-367, fig.

Clark, Bracy.—Observations on the genus Œstrus. Transact. Linn. Soc., London, 1797, vol. 3, pp. 289–329.

Clark, Bracy.—An essay of the Bots of horses and other animals. London, 1815, p. 72. Supplementary sheet. Discovery of the Fly of the White Bot, p. 4.

Clark, Bracy.—Of the Insects called Œstrus by the ancients, and of the true species intended by them under this appellation, etc. Transact. Linn. Soc., London, 1827, pp. 402–411.

Clark, Bracy.—Note on *Œstrus equi;* the Bot of Horses. Entom. Magaz., 1838. Vol. V, pp. 336–338.

Clark, Bracy.—An Appendix or Supplement to a treatise on the Œstri and Cuterebræ of various animals. Transact. Linn. Soc., London, 1843, Vol. XIX, pt. 2, pp. 81–94.

Clark, Bracy.—Addenda 1848, 1 p., fig. (2 nov. spec.). On the larva of *Œstrus cervi.* Zoologist, 1846, pp. 1569–1570, fig.

Davis, A. H.—Vitality of *Œstrus bovis.* Entom. Magaz., 1835, Vol. III, p. 103.

Fitch, A.—Emasculating bot fly (*Cuterebra emasculator*). Third Rept. N. Y. Entom., p. 478, No. 210.

Goudot, Justin.—Observations sur un diptère exotique dont la larve nuit aux boeufs (*Cuterebra noxialis*). Ann. Sc. Nat., ser. 3, 1845, T. 3, pp. 221–230.

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